0000004

Chicago Dock and Canal Trust

REPORT

Work Plan for Characterization of Radioactive Contamination

part I

316 E. Illinois St.
Chicago, Illinois

STS Consultants Ltd.
Consulting Engineers

2.0 MOBILIZATION AND SITE CONTROL

There will be limited mobilization for the Field Investigation. The surveying is scheduled to be performed the week before the radiation monitoring and sampling activities. The mobilization for sampling will include bringing a CPT rig to the site and constructing a decontamination pad for containment of decontamination fluids. The mobilization activities will also include bringing a portable toilet to the site. A locking storage trailer will be provided to securely contain any investigation-generated wastes (i.e., decontamination liquids, soil cuttings, gloves, coveralls, etc.).

Arrangements will be made with the manager of the parking lot for scheduling the radiation survey and sampling activities. **The parking lot will be closed for a minimum time period to complete the surveying and sampling. It is anticipated that the lot will be closed for four days over two consecutive weekends.** ~~It is anticipated that about one-fourth of the lot will be closed for a given period of time to allow for radiation monitoring and sampling activities. Depending on the time period that people park and the possibility of moving parked cars, it may be necessary to close off up to one-half of the site at a time, to allow for proper monitoring and sampling. Site work activities will be scheduled to minimize the disruption to the normal operation of the lot, to the extent possible. A meeting with the lot operator management will be held in advance of the work to discuss the work and potential impact on operations.~~

2.1 Review Meeting

After approval of the Work Plan, a review meeting will be held with the USEPA, Chicago Dock, and STS and subcontractor representatives. The agenda for the meeting will be resolving any questions concerning the activities and schedule for the Field Investigation. All participants will read and formally acknowledge the provisions of the health and safety plan before initiating on-site work. Provisions for site security, mobilization, emergency procedures, delegation of responsibilities, and channels of communication will be discussed in detail.

2.2 Site Safety

The Health and Safety Plan is included as Appendix B. The plan outlines the activities to be performed, provides an assessment of associated risks, and presents action criteria for control of risks.

The potential radioactive materials are presently confined by the asphalt pavement. The work areas, where subsurface exploration is performed, will be considered control areas with no eating, drinking, chewing, or smoking within a radius of 5 meters (15 to 20 ft.) of subsurface work. **Restricted areas will be delinated by tape, rope and/or signs. The control area will be delineated by safety cones and caution tape. Access to the control area will be limited to only those persons directly involved with the performance of the task outlined in this Work Plan.** Special controls are given for work in areas where the general area gamma exposure rate exceeds 400 μR/hr (i.e., 0.4 milliroentgen per hour) **which is 20% of the limit for unrestricted area exposure rates per Illinois Radiation Protection Regulations (32 IAC 340.320 (b)(2)(B)).**

2.3 Site Security

The property is in downtown Chicago in a commercial area. The site is an active parking lot which services businesses in the adjoining area. The use of all or portions of the property by the public will be terminated during the investigation activities in order to expedite the completion of work and minimize the potential of exposure to the public. It is anticipated the majority of the field investigation will be performed over the weekend when the parking lot can be closed off from the public. In any case, operations on the site will be managed to minimize the potential of any off-site release, the exposure to people on the site, and intentional or inadvertent interaction of the public with contaminated materials on the site.

For those tasks performed on weekdays, it may be necessary to allow public access to sections of the property throughout the investigation. To effectively perform the investigation, minimum areas of one-fourth of the property will be isolated from public

access. After completion of the gamma survey, areas for subsurface sampling will be isolated from public access to allow safe and expeditious performance of the work.

Under no circumstances will CPT borings or material from the subsurface be left unattended. All borings and subsurface material will be isolated when project personnel or security guards are not present. Borings may be isolated by covering the surface opening or by leaving the casing in the boring. Isolation of material may be provided by placing material in drums and locking the drums in a trailer. The trailer would be "disabled" or secured to existing facilities (e.g., the guardrail) to prevent removal of the trailer from the site.

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET CHICAGO, ILLINOIS

FOR: Chicago Dock and Canal Trust

Project Coordinator: Richard G. Berggreen
Assistant Project Manager: Craig S. Rawlinson

March, 1994
Revised May 5, 1994

STS CONSULTANTS, LTD.
111 Pfingsten Road
Northbrook, Illinois 60062

CDock:AA1:seb

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF APPENDICES

WORK PLAN CHANGE REQUEST FORM

Change No. _____ (Copy to Work Plan Margin as (#).)

Initiator Name: _____	Date: _____	Time: _____

DESCRIPTION OF CHANGE:

REASON FOR CHANGE:

IMPACT OF CHANGE:

APPROVED:

Project Coordinator: _____ Date: _____

EPA On-Scene Coordinator: _____ Date: _____

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET CHICAGO, ILLINOIS

1.0 BACKGROUND

1.1 Introduction

In June of 1993, the U.S. Environmental Protection Agency (EPA) and Illinois Department of Nuclear Safety (IDNS) measured gamma radiation on portions of the 316 East Illinois Street site in Chicago, Illinois, owned by Chicago Dock and Canal Trust. Property records indicate that Lindsay Light Company leased the site from about 1915 to 1932. Lindsay Light Company made lantern mantles. Although information from this time period is sketchy, Monazite ore is believed to have been processed at the site. The 316 East Illinois Street site is herein referred to as "the property" or the 316 East Illinois site.

1.1.2 Administrative Order by Consent

On July 15, 1993, the EPA provided a draft Administrative Order by Consent (AOC) to Baker & McKenzie, legal counsel for Chicago Dock and Canal Trust. The AOC required Chicago Dock to prepare a Work Plan for site investigations. The AOC was agreed upon by Chicago Dock and USEPA and signed on January 27, 1994. The AOC is presented in Appendix A. This Work Plan is in response to the AOC.

1.1.3 Objective

This Work Plan describes the activities for characterizing the radioactive materials present at the 316 East Illinois Street site. The characterization includes determining the type and relative quantities of the radioactive materials present and the Resource Conservation and Recovery Act (RCRA) characteristics as defined in 40 CFR 261.

~~Groundwater samples will be obtained from four shallow monitoring wells installed on the site during a due diligence investigation conducted by STS Consultants, Ltd. (STS) in 1992.~~

The Field Investigation Plan in Section 3.0, Health and Safety Plan in Appendix B, Project Schedule in Appendix C, and Quality Assurance Project Plan in Appendix D are incorporated into the Work Plan.

1.1.4 Scope of Work

The Field Investigation will include a surficial radiation survey, cone penetrometer testing (CPT), downhole gamma logging, subsurface soil sampling, ~~groundwater sampling,~~ and sample analysis of soil ~~and groundwater~~ samples. **A detailed description of these tasks are outlined in Section 3.0 of this Work Plan.** The following items briefly describe these activities:

a. Perform land survey to provide a definitive basis for locating overland radiation survey and sampling locations. The survey will provide both coordinates and elevation bench marks.

b. Perform overland gamma radiation survey on a 6 meter grid spacing over the entire site. Grid spacing will be decreased to approximately 1 meter where the initial survey indicates elevated gamma radiation levels. The overland gamma survey will be performed with ~~a tissue equivalent dose-rate instrument (e.g., Bicron MICRO REM LE or equivalent)~~ **Ludlum Model 2220 NaI (Tl) gamma scintillometer** which measures **in counts per second. Where elevated readings above background are indicated, a Bicron Micro Rem tissue equivalent dose rate instrument will be used to augment the scintillometer data.** ~~exposure rate in micro rem per hour.~~

c. Perform a minimum of 8 CPT borings for a subsurface survey of gamma radiation levels. The CPTs will be performed in the suspected areas of contamination and at a minimum of two background locations to determine subsurface radiation levels. Gamma readings will be taken within the CPT

casing using a NaI gamma radiation detector. **Impact on sensitivity by the casing will be measured utilizing calibration soils. The lowest available concentration of calibration soil will be used.**

d. Collect samples from a minimum of 5 CPT borings and analyze the samples **by gamma specotroscopy** for ~~total~~ uranium, ~~total~~ thorium, Ra-226 **and,** Ra-228.~~and~~ **The soil samples will also be subject to analysis for** RCRA characteristics. **Isotopic uranium and thorium analyses will be performed on three soil samples with the highest gamma counts.** Splits of these samples will be made available to the EPA. Samples will be collected and managed under chain-of-custody procedures.

~~e. Collect water samples from the four shallow groundwater monitoring wells previously installed by STS Consultants, Ltd., as part of an investigation in 1992. The water samples will be analyzed for total uranium, total thorium, radium-226 and radium-228, and the metals listed in 40 CFR 141.11 of the EPA Primary Drinking Water Regulations.~~

1.1.5 Schedule and Project Deliverables

This schedule is based on anticipated periods for review and obtaining appropriate approvals. ~~The Work Plan is scheduled for delivery to EPA Region V on or before March 25, 1994. This schedule assumes the EPA will review and provide comments by April 8 and STS will submit the revised Work Plan to the agency by April 22, 1994.~~ Based on ~~an assumed two week expedited~~ approval by the EPA on May ~~6~~, 13, 1994, the Field Investigation activities are scheduled for the week**sends** of May ~~21~~14 and ~~28~~,21, 1994. Land survey and overland radiation survey activities will be performed the week**end** of May ~~21~~14-15, and the downhole radiation monitoring and sampling activities will be performed the week**end** of May ~~28~~.21-22. Assuming completion of the sampling activities by May 29, analytical results are scheduled to be available by July 29. All sampling and investigation activities will be completed on or before

September 23, 1994. A draft report will be issued within 60 days following September 23, 1994.

It is proposed that status meetings be held the weeks of ~~April 11~~ **May 13** (finalize issues related to the Field Investigation) ~~April 25~~, June 20, and August ~~11~~,5, 1994. This schedule for status meetings is based on the development of information and the need to discuss and resolve issues. An agenda for the meetings, including the status of activities and results, will serve as "Status Reports." Conference telephone calls can be used in place of status meetings. In addition to the meetings, a monthly progress report will be prepared once the USEPA has approved the Work Plan. The monthly progress reports will be submitted to the USEPA on-scene coordinator and will include the work completed to date and work items planned for the following month. Figure 1-1 provides a summary of the schedule.

1.2 Project Description and Site History

The Chicago Dock and Canal Trust (Chicago Dock) property, at 316 East Illinois Street, extends between East Illinois Street on the south to Grand Avenue on the north. It is bounded by Columbus Drive on the west and McClurg Court on the east. Figure 1-2 shows the general layout of the site. The dimensions of the site are 200 feet north to south, and 594 feet east to west which makes the site approximately 2.7 acres. Figure 1-3 is a location map, indicating the location of the property within the State of Illinois and the City of Chicago.

The USEPA measured gamma radiation levels on portions of the site in June, 1993. The USEPA has designated the site as Lindsay Light II. The site, which was leased to Lindsay Light prior to about 1933, is denoted herein as "the property". The property is presently undeveloped and has been used as a parking lot in recent years. The parking lot, operated by General Parking Company, is paved with asphalt and has guard rails that border it. The property is situated in an urban area called the Gold Coast, and is surrounded by commercial and residential buildings. A shopping mall is located approximately 200 feet to the southeast. The Chicago River is located 1/4 to 1/2 mile south of the site, and Lake Michigan is about 1/4 to 1/2 mile east of the site.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor of Chicago Dock and Canal Company, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock". Chicago Dock records indicate that a portion of the property was leased to Lindsay Light from about 1915 to 1932. Information from historic record searches indicates that there were several other industrial and manufacturing operations on and around the site. These activities, dating back to about 1900, apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks (STS92). These records also indicate that the property from 316 to 322 East Illinois was rented by Cooper's Stable prior to 1913. A two-story building on the property housed a stable for horses and wagons and a blacksmith shop.

In 1914, the Cooper Stable was divided in half, from east to west. The south half, fronting on Illinois at 316 E. to 322 E., was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.

Review of property records indicates that Lindsay Light probably performed its primary manufacturing operations in this area of Chicago at 161 East Grand Avenue, about one-quarter mile west of the property. The operations at 161 East Grand Avenue included the manufacturing of incandescent gas mantles. Some manufacturing and/or processing reportedly took place at the 316 East Illinois Site.

The principal ingredient in gas mantle manufacture is thorium as a nitrate. Small amounts of cerium, beryllium, and magnesium nitrates are also used. Thorium occurs in nature principally as the parent radionuclide thorium-232 in association with its daughter products in a decay sequence known as the Thorium Decay Series. Several thorium isotopes are also found within the Uranium and Actinium Decay Series. It is believed that the principal source of contamination at this site is thorium-232 and thorium decay series nuclides. The Thorium Decay Series is shown on Figure 3-2.

1.2.1 Prior Investigations

There are records of two site investigations at the 316 East Illinois property. In mid-1992, STS performed a due diligence investigation for POWER/CRSS related to the proposed purchase of property for the Proposed Northwestern Memorial Hospital Facility Redevelopment site. In mid-1993, the EPA and IDNS performed a radiation survey on the site, based on information in their possession which indicated that Lindsay Light had operations at the site.

1.2.1.1 STS Site Investigation

STS performed a site investigation at the property in mid-1992 (STS92). The investigation included the property between East Illinois Street and Grand Avenue, and the Columbus Drive and McClurg Court. These are also the property boundaries for the 316 East Illinois site (see Figure 1-2).

The 1992 STS site investigation report states that "over 20 borings, including four groundwater monitoring wells, and three test pits were performed to characterize subsurface conditions." Based on the 1992 STS investigation, the subsurface of the site consists of a layered sequence of fill over lake bottom sediments and glacial till. The 6 to 10 foot thick fill layer consists of rubble debris comprised of cinders, bricks, stone fragments, wood (1871 Chicago Fire debris), and sand and gravel. The rubble fill is underlain by what is likely sand fill (dredge spoil) which grades into the natural fine to medium lake bottom sand. At about 30 feet below ground is the top of a thick sequence of silty clay glacial till with occasional sand lenses which extends down to the underlying dolomite bedrock at approximately 120 feet.

The shallow water table was observed within the sand fill at about 12 feet below ground surface on-site. Based on the shallow monitoring well water level measurements, the water table appears to be relatively flat in this area with a shallow groundwater flow direction generally to the south.

A summary of the STS 1992 investigation is presented in Appendix E.

1.2.1.2 Radiation Investigations by USEPA and IDNS

USEPA and IDNS performed radiation surveys at several former Lindsay Light sites in the area of Chicago near the subject property in mid-1993. On June 1, 1993, they performed a radiation survey at the 316 East Illinois site. The information from this survey is given on Figure 1-2.

The records for the past use of the property indicate that the radiation levels measured may be due to residual material from Lindsay operations.

2.0 MOBILIZATION AND SITE CONTROL

There will be limited mobilization for the Field Investigation. The surveying is scheduled to be performed the week before the radiation monitoring and sampling activities. The mobilization for sampling will include bringing a CPT rig to the site and constructing a decontamination pad for containment of decontamination fluids. The mobilization activities will also include bringing a portable toilet to the site. A locking storage trailer will be provided to securely contain any investigation-generated wastes (i.e., decontamination liquids, soil cuttings, gloves, coveralls, etc.).

Arrangements will be made with the manager of the parking lot for scheduling the radiation survey and sampling activities. **The parking lot will be closed for a minimum time period to complete the surveying and sampling. It is anticipated that the lot will be closed for four days over two consecutive weekends.** ~~It is anticipated that about one-fourth of the lot will be closed for a given period of time to allow for radiation monitoring and sampling activities. Depending on the time period that people park and the possibility of moving parked cars, it may be necessary to close off up to one-half of the site at a time, to allow for proper monitoring and sampling. Site work activities will be scheduled to minimize the disruption to the normal operation of the lot, to the extent possible. A meeting with the lot operator management will be held in advance of the work to discuss the work and potential impact on operations.~~

2.1 Review Meeting

After approval of the Work Plan, a review meeting will be held with the USEPA, Chicago Dock, and STS and subcontractor representatives. The agenda for the meeting will be resolving any questions concerning the activities and schedule for the Field Investigation. All participants will read and formally acknowledge the provisions of the health and safety plan before initiating on-site work. Provisions for site security, mobilization, emergency procedures, delegation of responsibilities, and channels of communication will be discussed in detail.

2.2 Site Safety

The Health and Safety Plan is included as Appendix B. The plan outlines the activities to be performed, provides an assessment of associated risks, and presents action criteria for control of risks.

The potential radioactive materials are presently confined by the asphalt pavement. The work areas, where subsurface exploration is performed, will be considered control areas with no eating, drinking, chewing, or smoking within a radius of 5 meters (15 to 20 ft.) of subsurface work. **Restricted areas will be delinated by tape, rope and/or signs. The control area will be delineated by safety cones and caution tape. Access to the control area will be limited to only those persons directly involved with the performance of the task outlined in this Work Plan.** Special controls are given for work in areas where the general area gamma exposure rate exceeds 400 μR/hr (i.e., 0.4 milliroentgen per hour) **which is 20% of the limit for unrestricted area exposure rates per Illinois Radiation Protection Regulations (32 IAC 340.320 (b)(2)(B)).**

2.3 Site Security

The property is in downtown Chicago in a commercial area. The site is an active parking lot which services businesses in the adjoining area. The use of all or portions of the property by the public will be terminated during the investigation activities in order to expedite the completion of work and minimize the potential of exposure to the public. It is anticipated the majority of the field investigation will be performed over the weekend when the parking lot can be closed off from the public. In any case, operations on the site will be managed to minimize the potential of any off-site release, the exposure to people on the site, and intentional or inadvertent interaction of the public with contaminated materials on the site.

For those tasks performed on weekdays, it may be necessary to allow public access to sections of the property throughout the investigation. To effectively perform the investigation, minimum areas of one-fourth of the property will be isolated from public

access. After completion of the gamma survey, areas for subsurface sampling will be isolated from public access to allow safe and expeditious performance of the work.

Under no circumstances will CPT borings or material from the subsurface be left unattended. All borings and subsurface material will be isolated when project personnel or security guards are not present. Borings may be isolated by covering the surface opening or by leaving the casing in the boring. Isolation of material may be provided by placing material in drums and locking the drums in a trailer. The trailer would be "disabled" or secured to existing facilities (e.g., the guardrail) to prevent removal of the trailer from the site.

3.0 FIELD INVESTIGATION PLAN

3.1 Objective

The primary objective of the field investigation is to provide a characterization of the radiological materials present at the 316 East Illinois Street site. The characterization includes determining the radioactive materials that are present, the magnitude and extent, and the Resource Conservation and Recovery Act (RCRA) characteristics as defined in 40 CFR 261.

3.2 Work to be Performed

The Field Investigation will include a surficial gamma radiation survey, cone penetrometer testing (CPT), downhole gamma logging, subsurface soil sampling, ~~groundwater sampling,~~ and soil ~~and groundwater~~ analyses. The following items briefly describe these activities:

a. Perform land survey to provide a definitive basis for locating radiation survey and sampling locations. The survey will provide both coordinates and elevation bench marks.

b. Perform overland gamma radiation survey and record readings on 6 x 6 meter grid lines over the site. Additionally, the inter-grid areas will be screened in a reconnaissance gamma survey walkover to identify any anomalous gamma readings between grid stations. Survey grid point spacing will be decreased to approximately 1 meter where the initial survey analyses have suggested elevated gamma radiation levels. The radiation survey will be performed with a **NaI gamma scintillometer**~~tissue equivalent dose-rate instrument (e.g., Bicron MICRO REM LE or equivalent)~~ which measures **counts per second.** ~~exposure rate in micro rem per hour.~~ The survey will be conducted such that ~~exposure rate~~ measurements are taken at

1 meter and 1 cm above the ground surface at each grid location. The inter-grid areas will be surveyed in a "zig-zag" fashion at the 1 cm level.

c. Perform a minimum of 8 CPTs for gamma logging. The CPTs will be performed in the suspected areas of contamination and at a minimum of **two** ~~one~~ background location to determine subsurface radiation levels and obtain samples of the subsurface materials. Gamma logs will be taken within the CPT casing using a (0.5 in. x 1.5 in.) NaI gamma radiation detector.

d. Collect **two soil** samples from a minimum of 5 CPT borings and analyze the samples for **gamma spectroscopy uranium and thorium**~~total uranium, total thorium~~, Ra-226, Ra-228, **isotopic uranium, isotopic thorium,** and RCRA characteristics. Splits of these samples will be made available to the EPA. Samples will be collected and managed under chain-of-custody procedures.

~~e. Collect water samples from the four shallow groundwater monitoring wells previously installed by STS Consultants, Ltd., as part of an investigation in 1992. The water samples will be analyzed for total uranium, total thorium, radium-226 and radium-228, and the metals listed in 40 CFR 141.11 of the EPA Primary Drinking Water Regulations.~~

The following sections describe the basic tasks in the investigation plan.

3.2.1 Site Survey

A land survey will be performed by surveyors licensed in the State of Illinois. The survey will provide fixed points for both coordinates and elevation. Fixed survey pins will be placed at the four corners of the property and near the center of the property.~~, and coordinates for the existing monitoring wells will be determined. Additionally,~~ **The** ~~the~~ approximate location of the former stable building will be located to the extent possible from available site plans and records. **A utility meet will be coordinated to locate the subsurface utilities on site.** The survey will provide stations marked at 30 meter centers, sufficient for locating an accurate 6 meter by 6 meter grid for

performing the gamma survey. Figure 3-1 illustrates an example of the radiation monitoring grid.

Sufficient benchmarks will also be provided for determining future sampling locations. If necessary, the site will be re-surveyed after sampling to provide the coordinates for sampling locations.

3.2.2 Radiation Survey of Site

An overland gamma radiation survey will be conducted of the property and the public right-of-way along East Illinois Street directly south of the site. Based on previous surficial surveys conducted by STS, the data from which was provided to USEPA, it is anticipated that the 6 meter station spacing will be sufficient for the majority of the site. However, the spacing will be decreased to approximately 1 meter in the **area of the former stable building and the** south central portion of the site where previous surveys have suggested anomalous gamma radiation levels. The size of the area expected to be covered by the compressed grid is estimated to measure approximately 45 meters x 45 meters. This area will extend sufficiently far to characterize the limits of any identified elevated gamma radiation areas. In addition, continuous screening will be conducted within the internal areas of the grid in order to identify potential isolated areas of high exposure rates and/or other anomalies.

The survey will be conducted by two teams using identical instrumentation. Duplicate analyses will be conducted at approximately 10% of the stations. The duplicate analyses will be utilized to correlate and verify consistency of readings taken by each team.

The overland gamma survey will be conducted per MJW Radiological Procedure No. 40 (Attachment A) appropriately modified to meet grid, instrumentation, and data collection requirements specific to the site as discussed above. Two readings will be made at each sample location at one meter and at the ground surface (elevation approximately 1 cm). The area formed by any four survey points will be scanned in a diagonal "zig-zag" fashion at one centimeter to determine potential radiation levels within the unsurveyed area. **This "zig-zag" survey will cover the intergrid area at a**

minimum spacing of approximately 1 meter passes, continuously reading the scintillometer for an elevated response. Area survey results of each grid square will be reported as a general average reading and a maximum reading. **The locations of maxima will be marked and recorded.** The grid area surveys will be designated by the survey locations of opposite corners (e.g., N36E102/N42E108).

The radiation survey will be performed using a Ludlum Model 2220 NaI (Tl) gamma scintillometer. This detector generates measurements in counts per second.

Background levels of gamma radiation will be established by means of a gamma survey of stations along three traverses, each consisting of a minimum of 10 points. The three traverses include one along the west margin of the parking lot located immediately east of the site across McClurg Court. This is referred to as the off-site traverse. Two on-site traverses will be located along the eastern-most and western-most margins of the site. The mean plus 2 standard deviations will be calculated for the off-site traverse and compared to the mean plus 2 standard deviations for the on-site data. If the two data sets are found to be components for single population using a Student's "t" test, the three traverses will be combined and the mean plus 2 standard deviations will be set as the background.

If the on-site data show higher levels in the background surveys, background traverses totaling a minimum of 40 additional data points will be conducted in vicinity at grade parking lots within a one block radius of the site to establish a background value. That background will be mean plus 2 standard deviation of the off-site 50 data points.

In areas with elevated readings on the NaI gamma scintillometer, readings will also be taken with a Bicron MICRO REM LE detector which gives quantitative dose rate measurements. These readings will be taken at the ground surface at appropriately spaced grid points and intergrid areas within the area(s) of elevated gamma readings and within the former stable building footprint.

~~The Bicron MICRO REM LE survey instruments used to conduct this work employ a tissue equivalent detector which exhibits a very flat response over a wide energy range.~~

~~All overland gamma survey results will be reported in μrem/hr. Background rates will be determined at several locations in the vicinity of the site. In areas with elevated readings on the Bicron LE, readings will also be taken with a Ludlum Model 44-10 high energy 2 in. x 2 in. NaI (Tl) gamma scintillometer. This detector will facilitate correlation with other survey data generated with measurements in counts-per-second using a similar NaI type detector. These readings will be taken at the ground surface at appropriately spaced grid points and inter-grid areas within the area(s) of elevated gamma readings.~~

3.2.3 Cone Penetrometer & Gamma Logging

The Cone Penetrometer Test truck (CPT) will be used in combination with downhole geophysical logging of gamma radiation to provide vertical delineation of the extent of contamination. The depth of the investigation will extend below the surficial fill materials, and will include the naturally occurring soils. The CPT holes are anticipated to extend to approximately 16~~-20~~ feet deep. However, if initial CPT holes and gamma logging indicate much shallower depth of contamination, the subsequent depth of CPT holes may be decreased with the possibility of increasing the total number of investigation locations.

The CPT procedure proposed for this investigation utilizes a sacrificial cone tip mounted on a stainless steel casing with a 1.75-inch outer diameter and a 1.38- inch inner diameter. Because the cone penetrometer is hydraulically advanced into the soil, no soil cuttings are generated.

Once the CPT casing has been extended to the desired depth, the hole will be geophysically logged to record gamma radiation levels in counts per second (cps) as a function of depth. Gamma logging will be performed using the standard logging procedures in Section 3.3. The CPT down hole gamma survey will use a Colog MXG logger equipped with electronically controlled winch assembly, computer interface, and a Mount Sopris Model HLP-2375-I gamma radiation probe. The Mount Sopris probe is equipped with a 0.5-inch by 1.5-inch NaI(TI) crystal which is capable of providing vertical resolution of approximately 1.5-inches. At present, it is anticipated that the logging would be conducted through the steel casing. Sensitivity runs will be

conducted using calibration drums of known source intensity. **The sensitivity runs will be performed using the lowest concentration drums available.** If the probe response is determined to be significantly compromised (sensitivity diminished by 50% or more based on calibration) by the steel casing, temporary PVC casing will be used to secure the borehole during logging. However, use of the temporary PVC casing will likely necessitate the use of a larger cone penetrometer tip and casing.

The holes will be logged from the base up, with logging speed, multiplier setting, and other operational variables determined in the field to maximize probe response and resolution while still achieving acceptable logging production. **The logging speed will be approximately eight feet per minute with digitized readings every 0.10 feet.** To verify the replicability of the instrument response, a base station consisting of a CPT boring will be logged at the start and finish of the downhole geophysical program.

STS anticipates that the downhole gamma characterization will be conducted during a two-day period. The study will include a minimum of 8 locations. Based on typical production rates, it is anticipated that approximately 12 cone holes can be advanced and geophysically logged within the two-day period, while leaving sufficient time for decontamination between locations. With the exception of the CPT base station boring which will be sealed upon completion of the subsurface survey task, the CPT holes will be sealed with a cement-bentonite grout prior to mobilizing to the next location.

3.2.4 Soil Sampling and Analysis

Based on the results of the external gamma survey and the downhole gamma survey, locations and depths will be selected for the collection of soil samples. The objectives of the soil sampling and analysis are to identify the radioactive material, measure the activity, determine the soil concentration, and correlate with the downhole gamma data. At a minimum, subsurface soil sampling will include five locations. **Two samples will be obtained from each of the five locations for analysis.** Samples will be collected from the following areas based on the overland and downhole gamma logging:

- areas of suspected maximum gamma readings;
- areas representative of background gamma readings; and

- areas indicative of source area perimeter or transitional zones.

Soil samples may also be obtained from beneath the parking attendant booth area if either the overland or subsurface gamma surveys suggest significantly elevated radioactivity levels.

The samples will be collected using either a hydraulically pushed 3-inch diameter Shelby tube, if cohesive soils are encountered, or a hydraulically pushed 3-inch diameter split spoon sampler. The sampling procedures will be performed in general accordance with the standard sampling procedures in Section 3.3. An exception to the standard procedures is the spoon sampler will be hydraulically pushed. As a result, no blow counts will be recorded as part of any penetration test. The feasibility of hydraulically pushing these sampling devices at the depth of interest using the CPT rig will be evaluated during the initial two days of characterization work. If site fill materials are too dense for sampling using this equipment, a truck-mounted drill rig equipped with 4-1/4-inch inside diameter hollow stem augers will be mobilized to the site to perform the sampling.

A minimum of 14 soil samples including quality control samples will be analyzed **for uranium and thorium and daughter products, and radium-226 and radium-228** by gamma spectroscopy. Three (3) soil samples selected from the highest gamma count areas will be analyzed for isotopic uranium and isotopic thorium. The results of these analyses will quantify the specific gamma emitters present and identify potential natural interferences (e.g., potassium-40).

The natural radioactive decay schemes for thorium and uranium are given in Figures 3-2 and 3-3, respectively. Although all of the isotopes in the decay series do not emit gamma photons, results from the gamma emitting radioisotopes and the relationships of the decay products can be used to determine the presence of the primary radioisotopes in these decay series. The results from this approach will also be supplemented by the results from radiochemistry for uranium and thorium.

Gamma spectral analysis will be performed to determine the concentrations of Ra-226, Ra-228 and U-238 in soil samples. In accordance with IT Corporation Analytical

Services (ITAS), Table OR-4-9 (Appendix D), Ra-226 concentrations are determined by analysis of Bi-214 and Pb-214 daughters; Ra-228 is determined by analysis of the Ac-228 daughter, and U-238 is determined by analysis of Th-234 (assuming that U-238 and Th-234 are in secular equilibrium). It should be noted that the Ra-226 analysis may be hampered by interference from Th-232 decay chain isotopes and, U-238 and Th-234 may not be in secular equilibrium.

Determination of the principal suspected radiological contaminant in soil, thorium, will be performed by sample digestion, sequential separation by anion exchange and alpha spectrometry analysis. The uranium isotopes U-234 and U-235 will also be analyzed using this method. All samples will be analyzed by the Oak Ridge laboratory of ITAS. Even though most methods for analysis have been identified in Table 3-1, STS will defer to ITAS analytical experts on suggested methods of analysis to obtain the most accurate results possible.

Algorithms from previous environmental assessments will be used for initial evaluations of the borehole gamma logs (x pCi/g = 0.0015*m counts/min). The final correlations for the borehole gamma logs will be based on correlations with the gamma spectroscopy result for Ra-226 and Ra-228, as described in the standard procedure in Section 3.3.

Two (2) soil samples will be selected based on radioactivity and physical appearance (PID readings, stains, odor, etc.). These samples will be analyzed for toxicity characteristic leaching procedure (TCLP) organic compounds (volatile and semi-volatile) **and RCRA metals.** ~~as well as radiological parameters (radium, total uranium,total thorium).~~

Samples from the borings will also be analyzed for RCRA characteristics. The samples will be analyzed for the RCRA characteristics of corrosivity, ignitability, **reactivity,** and toxicity. The analyses for the toxicity will be performed using Methods 1311, 8240, 8270, and 7000, including the analysis for volatile organic compounds (VOC), semi-volatile organic compounds, RCRA metals. The TCLP tests will not include the analyses for pesticides and herbicides, based on the history of the site.

Three samples will also be selected from those showing the highest gamma counts. Those three samples will be analyzed for isotopic thorium and isotopic uranium.

The sampling and analyses are given in Table 3-1. The information indicates the samples that will be collected, the specified analytical methods, and the ~~field and~~ trip blank samples that shall be **analyzed**~~collected~~. The EPA method number is given for all of the radionuclide analyses to be performed. The majority of the procedures for performing these analyses are derived from the HASL-300 manual for radionuclide analysis, a recognized industry standard. The container requirements and other information are given on Tables 3-2 through **3-6**.~~3-7.~~

~~3.2.5 Groundwter Samples~~

~~Four groundwater monitoring wells were installed during a site assessment in mid-1992. These wells have locking surface closure devices. The information on the construction of the wells is given in Appendix E.~~

~~The wells will be sampled using the procedures in Section 3.3. Samples will be analyzed for metals, radium-226 and radium-228, total uranium and total thorium using the sampling methods in Section 3.3 and analytical procedures identified in Appendix D. The samples will be filtered in the field.~~

3.2.5 QA/QC of Samples

The collection of field and trip blank samples and other QA/QC samples is indicated in Table 3-1. Laboratory blank and method spike samples will be analyzed as specified by the applicable methods in Appendix D.

3.2.6 Sample Management

Samples will be collected using chain-of-custody procedures. The samples will be stored under chain-of-custody and cooled as specified by SW 846 (EPA86). The

samples will be shipped to ITAS' laboratory by Federal Express, or an alternate laboratory (accepted by EPA and Chicago Dock). The samples will be shipped daily or every other day to ensure compliance with sampling holding times. Copies of the chain-of-custody sheets will be made available to the EPA.

Tables 3-2 through 3-6~~,3-7~~ provide summaries of the specific samples that will be collected at each location, the methods to be used for analysis, appropriate sample containers, requirements for preservatives, and holding times. QA samples that are to be collected/shipped with the samples from the various locations are also indicated. Sampling procedures (Section 3.3) provide the specific directions for the field personnel for collection of the samples and for the required analyses of samples. This information shall be used for filling out chain-of-custody sheets, preparing shipments of samples, and specifying the required sample analyses.

Samples will be analyzed by gamma spectrum analysis as specified by the procedure in Appendix D. ITAS Laboratory will perform the RCRA characterization analyses and radiochemistry analyses using their standard procedures and the EPA methods denoted in Appendix D.

3.2.6.1 Sample Designation

A sample numbering system will be used to identify each sample, duplicate and blank. Each sample identifier will include the project identifier code, sample type and location code, and a sampling event code. The Team Leader will maintain a log book containing the sample identification listings.

A. Project Identifier Code

A two-letter designation will be implemented to identify the sampling site. The project identifier will include "CD" for Chicago Dock.

B. Sample Type and Location Code

Each sample collected will be identified by a 1- or 2-letter code to identify the sample type. The sample type codes are:

~~G - groundwater sample from completed well~~
S - split spoon soil sample
~~TB - trip blank~~
MS - matrix spike

The location code will follow the sample type code. The location code for soil samples consists of two coordinates relative to the 6 meter grid stations that indicate the sample location. (60N18E refers to the grid point at 60 m north and 18 m east of the 0-0 station at the southwest corner of the site.) The split spoon soil sample coordinates will be followed by a sample depth, in feet, relative to the ground surface.

~~Groundwater location codes are identical to the well labels presented in Appendix E (STS 92).~~

C. ~~Sampling Round Code~~/Duplicate Code

~~Groundwater samples will have a numeric identifier after the well number to signify the sampling round. Soil samples will not have round codes, because they represent a one-time sampling at a unique location.~~ Duplicate samples will be designated by ~~the round code, if used, followed by~~ **a 9 following the sample depth.**

D. Examples of Sample Numbers

Examples of sample number codes are as follows:

- ~~CD-GMW128-01 = Chicago Dock, groundwater sample collected from existing monitoring well MW-128, sampling Round 1.~~
- CD-S60N36E-2-4 = Chicago Dock, split spoon soil sample collected at Station 60 meters north, 36 meters east, from 2 to 4 feet below the ground surface.
- ~~CD-GMW130-01-9 = Chicago Dock, groundwater sample collected from existing monitoring well MW-130, sample Round 1, duplicate.~~
- **CD-S60N36E-6-8(9) = Chicago Dock, split spoon soil sample collected at station 60 meters north, 36 meters east, from 6 to 8 feet below the ground surface, duplicate.**

3.2.7 Closure of Borings

All CPT borings will be filled by grouting or with bentonite, unless the holes collapse during withdrawal of equipment. The surface will be capped with a minimum of 4 inches of a portland cement concrete mixture which will be finished off flush with the existing parking lot grade.

3.2.8 Decontamination of Equipment

Equipment which comes in contact with potentially contaminated material will be cleaned after each use. **Decontamination procedures are detailed in Attachment H.**

3.2.8.1 CPT and Soil Sampling Equipment

The CPT rig and associated sampling equipment will be decontaminated prior to arrival on site, between CPT locations, and prior to it being released from the site to prevent the chance of cross contamination from one location to another or release of contaminated material from the site. The CPT rig will not be released for maintenance or repair during the site activities, without proper decontamination and radiation surveys. A small decontamination area will be established prior to the initiation of CPT activities. This decontamination area will be capable of containing all decontamination fluids for approved disposal.

Decontamination will consist of combinations of steam cleaning, non-phosphate detergent wash, water rinse, and distilled water rinse as described below. An intermediate rinse with acetone may be used.

All tools used for soil sampling and packaging, including split-barrel samplers, sample-cutting knives, etc., will be decontaminated prior to the collection of each sample. Decontamination of these tools, which may be done at the sampling site, will include a detergent wash, distilled water rinse, solvent rinse, and a second rinse with distilled water. Drying time will be allowed after rinsing.

~~3.2.9.2 Water Sampling~~

~~Equipment used for well development, water level measurements, and collection of samples will be decontaminated, dedicated to each sampling point (i.e., dedicated bailers) or disposable. The decontamination of equipment for developing wells will be similar to that for sampling equipment in Section 3.3.4. The electrical sounding or measuring tapes used to measure water levels will be cleaned with non-phosphate detergent and rinsed with distilled water upon removal from each well, to avoid cross-contamination between wells. Solvents may be used, if necessary, based on field observation.~~

~~Samples will be taken with teflon bailers which have been decontaminated prior to sampling and decontaminated between sampling locations. A new piece of nylon rope will be used as the hoisting line for each sampling location. The methods specified for CPT equipment will be used, except it may not be necessary to use a solvent rinse.~~

3.3 Standard Sampling and Analysis Procedures

3.3.1 Surface Gamma Survey Data Collection

The surface gamma survey will be performed for the purpose of identifying areas of elevated gamma radiation which will serve to guide subsurface survey and sampling efforts. A site grid will be laid out and marked by a licensed Illinois surveyor prior to initiation of the overland gamma survey. This grid will include, to the extent possible from available records and site plans, the location of the former stable which occupied 316 to 322 E. Illinois.

The entire site will be surveyed at a minimum 6 meter x 6 meter grid. Where anomalous gamma radiation levels are identified, a 1 meter x 1 meter grid will be surveyed. Inter-grid areas will also be surveyed.

The instruments to be used are **Ludlum 2220** ~~Bicron MICRO REM LE tissue equivalent~~ survey meters. Two teams of survey personnel will survey the site in accordance with the Gamma Survey and Equipment Operating Procedures presented in Attachments A and ~~B~~**G**, MJW Radiological Control Procedures 40 and ~~41~~**27**.

3.3.2 Subsurface CPT Gamma Survey Data Collection

3.3.2.1 Objective

Measurements of gamma radiation will be taken in cone penetration test (CPT) holes at selected locations. The locations will be selected from the overland gamma survey (Section 3.3.1), to allow evaluation of subsurface gamma radiation at background locations, at locations showing the highest gamma radiation readings, and at locations representative of the transition readings between anomalously high levels and background levels.

Measurements will be taken in cased CPT borings from the ground surface to depths where readings indicate background levels of gamma radiation **or natural soils are reached, whichever is the greatest depth**. The bore holes will be cased with stainless steel CPT casing. Alternatively, if calibration runs show significant deterioration of sensitivity due to the stainless steel casing, PVC casing may be used.

3.3.2.2 Required Equipment

The following equipment will be required to perform the subsurface CPT gamma survey:

- CPT rig
- Mount Sopris gamma probe
- Winch assembly
- Colog gamma data logging unit
- Pavement corer

3.3.2.3 Sampling Design

Sampling locations will be selected based on the results of the overland gamma survey described above under Section 3.3.1. Grid station locations will be determined and assigned for each of the proposed sampling locations. Initially, eight sample locations will be selected to include two background locations where gamma readings are at or below 20 μrem/hr.; three locations where gamma readings are anomalously high, and should include the highest gamma readings which can be distinguished by a spacing of greater than 3 meters; and three locations representative of transition zones between elevated gamma readings and background gamma readings. Additional locations shall be selected and investigated as time allows in the following order of priority:

- one transition zone sample,
- one high gamma reading sample,
- a background sample.

One boring will be placed adjacent to the parking attendant booth, either as a background, a transition, or a high level reading during the first round of sampling.

The order of the initial subsurface survey will precede from two background locations through three transition zone locations and finally to the three highest gamma reading locations. This order will diminish potential for cross contamination from the locations with highest gamma readings to transition or background survey points.

The boring procedure will begin with a 4-inch diameter core being removed from the pavement. The core will be screened for radiation, and as appropriate, placed in a 55-gallon storage drum for management and disposal. **Materials exhibiting gamma readings (scintillometer readings) above background levels will be stored separately from apparent background level materials. Materials in both the apparently contaminated drum and apparently uncontaminated drum will be analyzed for waste characterization in accordance with the requirements of the proposed disposal facility, Envirocare in Utah.**

The CPT rig will be positioned over the cored hole and the cone advanced to a depth of 5 meters or 16 ft.

The Mount Sopris gamma logger will be positioned at the bottom of the hole and the logging run will begin from bottom and proceed upward. The logging will be conducted at a rate determined from calibration runs.

If data analyses show elevated gamma readings extend to the bottom of the bore hole, the boring will be advanced an additional 3 meters (10 ft.) and the gamma survey will be rerun in this bore hole from bottom to top. **Inasmuch as it is recognized that the presence of saturated soil will somewhat attenuate the gamma radiation below the water table, if elevated gamma readings extend to depths below the water table, the probe withdrawal rate will be adjusted to allow increased count rates. It is anticipated that reducing the withdrawal rate for the interval below the water table by 50 percent will provide sufficient sensitivity to identify the anomalous gamma levels. The withdrawal rate will be further slowed if a 50 percent reduction does not provide sufficient count rates.**

Each bore hole will be grouted with cement bentonite grout (5 lbs. bentonite per one bag cement) before moving to the next bore hole. A pavement plug, consisting of neat cement, minimum 4 inches thick, will be placed above the cement bentonite grout.

3.3.2.4 Documentation

Gamma measurements in counts per second will be taken and recorded on the Colog gamma logging equipment. A graphic printout showing **average** gamma readings at 6 ~~inch each 1 ft.~~ depth intervals will be prepared. The gamma record will maintained both on a paper printout and on a floppy disk data file. Both the disk and paper record will be labeled with the CPT boring number, grid station, project number, date and time of data run, depth interval, logging speed, operator, sensitivity setting, and gamma probe number used.

In addition to the graphic printouts, a field log book will be utilized to document field activities. The Assistant Project Manager will be responsible for entries into the log book regarding activities performed, readings, depths, dates, times and personnel. The log book will contain sequentially numbered pages. The log book will be kept with the CPT rig until cone and sampling work is completed.

3.3.2.5 Data Analysis

The paper printout will be reviewed prior to moving off the site in order to document that the depth of gamma logging extends to background levels. The project manager and a QA officer will confirm background levels prior to moving off and grouting of the CPT bore hole.

3.3.2.6 Schedule

It is anticipated that one day will be necessary to pre-core bore holes. Two days will be utilized in the subsurface sampling survey. One day will be utilized for data analysis to select subsurface sample locations and sample depth intervals.

3.3.2.7 Decontamination

Decontamination **procedures are detailed in Attachment H.** ~~will be affected on the cone equipment using a decontamination wash unit attached to the bottom of the CPT rig. The equipment is decontaminated as it is retracted from the ground. The rods will be cleaned of adhering soil, and will undergo a wash utilizing a TSP solution and potable water followed by a distilled water rinse. All wash waters and solids recovered from decontamination will be placed in 55-gallon drums and stored on-site for subsequent disposal. All CPT equipment will be screened upon removal from the ground for elevated gamma radiation.~~

3.3.3 Soil Sampling

3.3.3.1 Objective

Soil samples will be collected from selected locations and depths for analysis. Analysis will identify background concentration and contaminant specific identification for ionizing radiation source parameters and RCRA hazard waste characteristics. The sample analyses will be used to assess disposal options for the contaminated materials and potential health and safety risks associated with exposure to the contaminants and concentrations measured. Samples will be collected at background, transitional, and elevated gamma radiation locations.

3.3.3.2 Required Equipment

Required equipment for the subsurface soil sampling will include the following:

- CPT rig,
- 3-inch diameter stainless steel split spoon sampler,
- Pavement corer,
- Soil sample containers.

Alternatively, if the CPT rig is found to be unable to advance the sampling equipment, hollow stem auger drilling equipment may be utilized in place of the CPT rig.

3.3.3.3 Sampling Design

Based on the overland gamma survey and subsurface CPT gamma survey, a minimum of five locations will be selected for soil sampling. The soil sample locations will be within a 1 ft. radius of the boring where down hole gamma logging showed a zone of interest. Sampling will proceed from background to transitional to high gamma reading locations in order to minimize potential cross contamination.

The grid location of the proposed sample boring will be measured and recorded. The pavement will be cored, using a 4-inch diameter pavement corer. A 3-inch split spoon will be hydraulically pushed with the CPT rig if the sample interval is at the ground surface or within the upper 18 inches. If the zone to be sampled is at some greater depth, the CPT rig will advance a cone to a depth 6 inches above the interval to be sampled, the cone will be removed, the depth of the boring measured, and the split spoon sampler will be hydraulically advanced 18 inches to recover the sample.

If the sampler cannot be pushed with the CPT rig, the pavement hole will enlarged to 8-inch diameter and 4-1/4 inch inside diameter hollow stem augers will be used to advance the boring to 6 inches above the sample depth. The 3-inch diameter split spoon sampler will be driven 18 inches with a standard penetration test hammer to recover the sample.

The recovered sample interval will be screened for gamma radiation using the Bicron LE and Ludlum Model 2220 ~~44-10~~ meters. Reading will be taken at a distance of 1 cm above the sample. The length of sample recovery will be measured and recorded. The sample will classified as to soil type based on visual observation, but minimum disturbance of the sample will be made in order to diminish potential for airborne contaminants. The sampled interval will be retained as a single sample.

Upon completion of sampling, borings will be grouted with a cement bentonite grout (5 lbs. bentonite per one sack cement) to within 6 inches of the ground surface. A neat cement plug will be added to close the hole flush with the ground surface.

All cuttings from borings, and pavement coring, will be drummed and stored in a locked storage facility on-site until the evaluation of radioactivity can be made, in order to determine potential disposal options. Drums will be labeled with specific boring numbers from which the cuttings were generated. Material showing obvious indications of contamination (field screening detections) will be segregated from other materials which are apparently non-impacted soils.

3.3.3.4 Documentation

Documentation for soil borings will include a boring log prepared for each boring, and a chain-of-custody form completed for each set of samples. The boring will include the identification of person preparing the field log, date, boring number, sample number, sampled interval, length of recovered sample, radiation levels, soil classification per Unified Soil Classification System, equipment used, PID readings, indications of contamination (stains, odors, etc.), and moisture content. Examples of boring logs and chain-of-custody records are included in Attachment F and G.

In addition to boring logs, a field log book will be utilized to document field activities. The Assistant Project Manager will be responsible for entries into the log book regarding activities performed, dates, times, and personnel performing the work. The log book will contain sequentially numbered pages. Each log book will be assigned a unique document control number. The log book will be kept in the on-site trailer during non-working hours.

3.3.3.5 Data Analyses

Samples will be analyzed as indicated on Tables 3.1 through 3.6.

3.3.3.6 Schedule

It is proposed that two days will be utilized to complete the soil sampling efforts. The schedule is shown on Figure 1-1.

3.3.3.7 Decontamination

Decontamination will proceed as specified **in Attachment H.** ~~above in Sections 3.2.9 and 3.3.2.7.~~

3.3.3.8 Field Sampling Summary Table

Refer to Table 3.1.

~~3.3.4 Groundwater Quality Sampling~~

~~3.3.4.1 Objective~~

~~The objective of this activity is to collect groundwater quality samples representative of the aquifer at the screened interval of the well.~~

~~3.3.4.2 Personnel and Responsibilities~~

~~The Groundwater Monitoring Field Technician - This person will be responsible for purging wells, collecting water quality samples, providing site safety monitoring during sampling, decontamination of equipment and proper disposal of purged water.~~

~~Chain-of-Custody Technician - This person will be responsible for chain-of-custody records, preparing sample bottles for sampling, packaging, and shipping samples with assistance from the sampling teams. This person will also be responsible for sample filtration, preservation and for performing pH and conductivity measurements.~~

~~Water Levels - A water level will be obtained using a weighted tape and sounding device or an electric water level meter, measuring to the nearest $\pm$0.01 ft. The depth of the well will also be measured and recorded at each sampling round. If a floating oil layer is suspected to be present, based on drilling or previous sampling observations, an oil-water interface probe will be used to measure the depth to fluid and depth to water.~~

~~Purging~~

If floating product is observed, a stainless steel bailer will be used to collect a sample of the floating product without purging. The stainless steel bailer will then be used to purge the well of three volumes. Purging will continue until temperature, pH and specific conductance stabilize within 5% or 0.2 pH units.

Purge water discharge will be collected in 55-gallon drums.

The purged water will be analyzed. Pending waste characterization results, it will be disposed of under manifests at a disposal facility permitted to accept the waste identified by characterization analysis.

Sample Collection

Water levels will be allowed to recover a minimum of 2 hours following purging prior to sampling. Samples will be recovered within 24 hours of completion of purging.

Samples will be collected utilizing a stainless steel bailer. (See Table 3.1 of the QAPP for required bottles, preservatives and handling).

All sample bottles will be labeled with the time of sample collection, in addition to the other chain-of-custody items prepared by the Chain-of-Custody Technician.

Samples collected from the bailer will be collected with a minimum amount of water disturbance.

Sample Handling, Preparation and Sample Analysis

All samples will be iced immediately after collection.

Groundwater samples undergoing metals analyses will be filtered through a 0.45 um pressure filtration device as soon as possible after sample collection.

Preservation will be conducted as specified in Table 3 of the QAPP.

pH and conductivity will be measured as specified in the QAPP.

Groundwater samples will be analyzed for the Safe Drinking Water Act list of metals, Radium-226 and Radium-228, and uranium isotopes in accordance with methods specified on Table 3.1 and Table 3.7.

Decontamination

Decontamination of the sampling and purging equipment will be conducted by washing in TSP solution using tap water followed by two rinses with distilled water.

Bailers used to sample oily groundwater will be decontaminated by rinsing with acetone followed by the same wash and rinse sequence. A new nylon rope to hoist the bailer will be used for each monitoring well.

4.0 REMOVAL ACTIVITY

This Work Plan covers only site characterization activities and does not cover the removal of contamination at the 316 E. Illinois site. Investigation-generated wastes from sample collection, personnel protection equipment and decontamination solutions and solids are the only waste material expected to be produced by the present investigation.

4.1 Management of Residuals from Sample Collection and Decontamination

Residual sample material will be collected, and the water from decontamination of equipment ~~and purging the monitoring wells prior to sampling~~ will be collected. Residual material will be placed in plastic-lined drums. The drums will be stored in a locked trailer on site, pending determination of disposal options. Preliminary discussions have been held with Envirocare of Utah regarding waste disposal.

The water from decontamination of equipment ~~and purging the monitoring wells~~ will be placed in drums. After completion of the field phase, the water will be sampled and samples sent to ITAS Laboratories for gross alpha and gross beta analysis. Disposal options will be specified based upon measured activity levels.

Since the CPT rig is to be used in lieu of a drill rig, no cuttings or other subsurface waste requiring disposal are anticipated from the gamma logging and soil sample collection activities.

The analyses required by the disposal facility will be conducted at ITAS, a Utah certified laboratory, in order to receive a permit for disposal. In addition to seeking a permit for disposal of the investigation-generated waste (soil cuttings, decon materials, etc.), it is proposed to obtain a permit for disposal of the material which may require disposal in the event of removal or remediation of contaminated material from this site. This permit for disposal, therefore, may be for materials

which represent contamination in addition to the contamination contained in the investigation-generated waste.

5.0 PROJECT CLOSE-OUT

5.1 Site Restoration

Site restoration activities for the CPT holes or soil sampling boreholes will consist of grouting and capping with cement. All CPT holes or borings will be sealed with a cement-bentonite (95% cement to 5% powdered bentonite) grout mix with the upper 4 to 6 inches consisting of a portland cement concrete plug. The borings will be filled flush with the existing pavement surface.

5.2 Waste Removal

The removal of the investigation-generated waste will be dependent upon the activity measured in the waste materials. Disposal options will be presented to USEPA upon determination of the activity and the volume and phase (liquid/solid) of the generated waste.

5.3 Decontamination Screening

All equipment which has come into contact with potentially contaminated materials will be decontaminated prior to leaving the site. All equipment will be surveyed for the presence of radioactivity and will be cleared by the Site Safety Officer prior to release from the site.

6.0 PROJECT MANAGEMENT

The project management organization is given in Figure 6-1. The work will be performed under EPA oversight. Ms. Verneta Simon, of the EPA - Region 5 office, Emergency and Enforcement Response Branch - Response Section III, will be the EPA On-Scene Coordinator (OSC). The project team approved to complete the work set forth in the AOC consists of STS Consultants, Ltd. (STS) of Northbrook, Illinois for geotechnical and environmental work, MJW Corporation, Inc. (MJW) of Buffalo, New York for the health physics work, and International Technology Corporation Analytic Services (ITAS) of Knoxville, Tennessee for analytical work.

Richard Berggreen of STS is the Project Coordinator. After approval of the Work Plan, communications between the EPA and representatives of the property concerning this work plan will be coordinated by Ms. Simon and Mr. Berggreen. Any designation of alternates by these individuals will be authorized in writing.

6.1 Responsibilities and Functions

Richard Berggreen, the Project Coordinator is responsible for ensuring full implementation of the Work Plan. The following identifies the key individuals and their responsibilities:

Project Manager, Richard Berggreen (STS): Responsible for overall conduct of all project work, establish project schedules, budget, and priorities; approve the recommendations of Project QA Officer and the QA requirements for the project; provide oversight of Field Investigation; approve documents prior to their distribution and use. Responsible for the preparation and submittal of monthly progress reports to the EPA.

Assistant Project Manager, Craig Rawlinson (STS): Responsible for supporting the Project Coordinator in accomplishing his responsibilities. The Assistant Project Manager is authorized to act as the Project Coordinator when the Project Coordinator is

not available. Will be in daily communication during field activities verbally or in writing with the OSC regarding project progress. Responsible for maintaining a site entry and exit log, and formally documenting other site activities.

Project Quality Assurance Officer, David Dooley (MJW): Responsible for ensuring the requirements, procedures, and practices for the project. Review, evaluate, interpret, and define the application of QA requirements, standards, and guidelines for the project; conduct or direct QA audits, surveillance, and other related activities; and certify the completion of all corrective actions.

Site Safety Officer, David Dooley (MJW): Responsible for monitoring compliance with the Site Safety Plan, providing emergency first aid, setting up decontamination facilities, making sure adequate health and safety equipment and supplies are available on-site, operating or overseeing the operating of personal or environmental health hazard monitoring, and overseeing the use of Personal Protective Equipment.

6.2 Revisions to Work Plan

Any revisions to the Work Plan will be done in accordance with the Administrative Order of Consent enclosed in Appendix A.

~~The Work Plan, after approval by Chicago Dock and the EPA, becomes the official plan for performing the characterization of the property and preparation of required reports. Changes in the Work Plan require the written concurrence of representatives of Chicago Dock, the EPA On-Scene Coordinator, and the Project Coordinator. If changes are required during the field work, modifications will be made on the Work Plan Change Request Form shown in Figure 6-2. The change number will be noted in the margin of the official on-site copy of the Work Plan (maintained by the Project Coordinator). The Work Plan Change Request Form will be signed by the EPA On-Scene Coordinator and the Project Coordinator. A Work Plan Change Request Form will be completed and provided to the Project Coordinator and On-Scene Coordinator for review and approval. Furthermore, any such changes shall have been verbally approved by the Project Manager. Written validation of any such changes shall be signed by Chicago Dock, the EPA On-Scene Coordinator, and the Project Coordinator within 10 working days of their initiation.~~

6.3 Project Schedule

See Appendix C.

REFERENCES

STS92 STS Consultants, Ltd., Report of Environmental Investigation. STS Project No. 27313-XH, September 29, 1992.

EPA86 U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste. Office of Solid Waste Emergency Response, PB88-239223, SW-846, Third Edition, September, 1986.

LIST OF FIGURES

Figure 1-1
Schedule for Work Plan Activities

Activity	Completion of Activity	Meeting
USEPA Approval of Work Plan	May 13, 1994	
Field Work Start-Up Meeting*		May 13, 1994
Field Investigation:		
Land Survey	May 14, 1994	
Overland Rad Survey	May 14, 1994	
Downhole Rad Survey/ Sampling	May 21, 1994	
Status Meeting		June 2, 1994
Laboratory Results	July 29, 1994	
Status Meeting		August 5, 1994
Completion of Investigation	September 23, 1994	
Draft Report Submitted	November 21, 1994	

*Assumes expedited USEPA review of previous activity.

CDock:AA3:seb

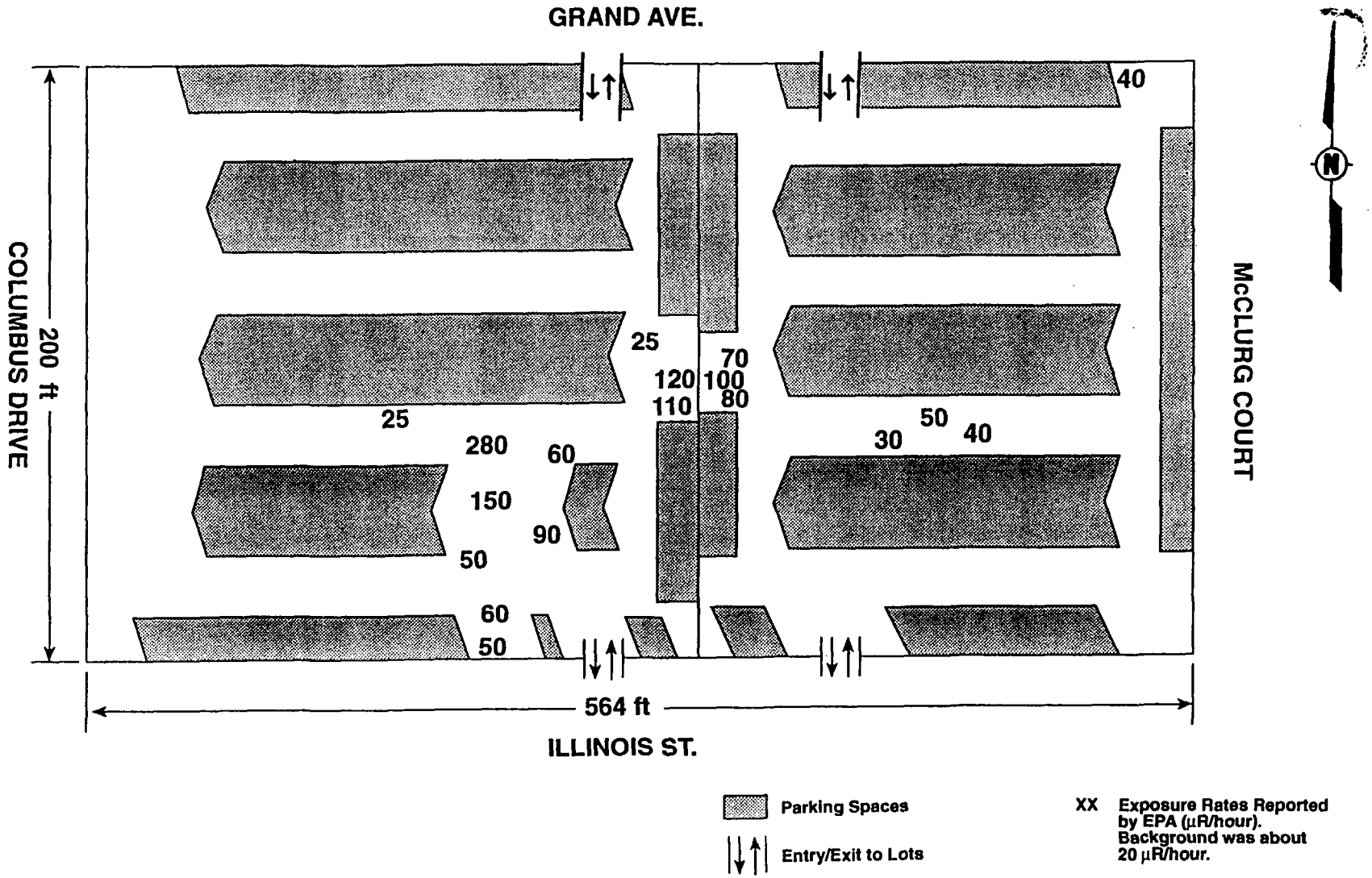
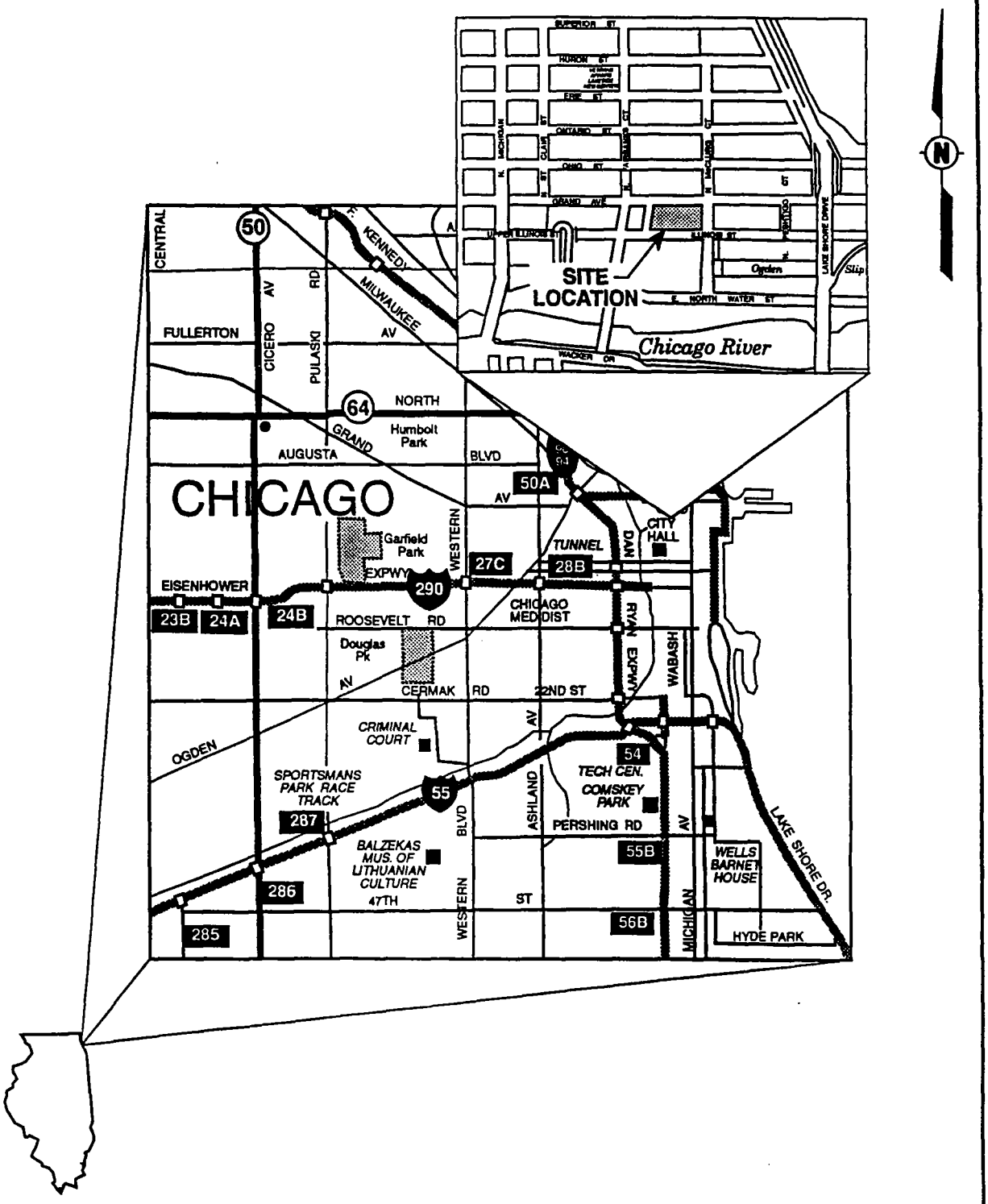


FIGURE 1-2	STS Consultants Ltd. Consulting Engineers	316 E. ILLINOIS ST. LOCATION SITE CHICAGO DOCK & CANAL 316 E. ILLINOIS STREET CHICAGO, ILLINOIS	DRAWN BY KKB — DATE 2-22-94 CHECKED BY — DATE APPROVED BY STN — DATE 2-22-94 CADFILE

SHEET NO. FIGURE 1-2 | SCALE NTS | STS PROJECT FILE | STS PROJECT NO. 27313-ZH

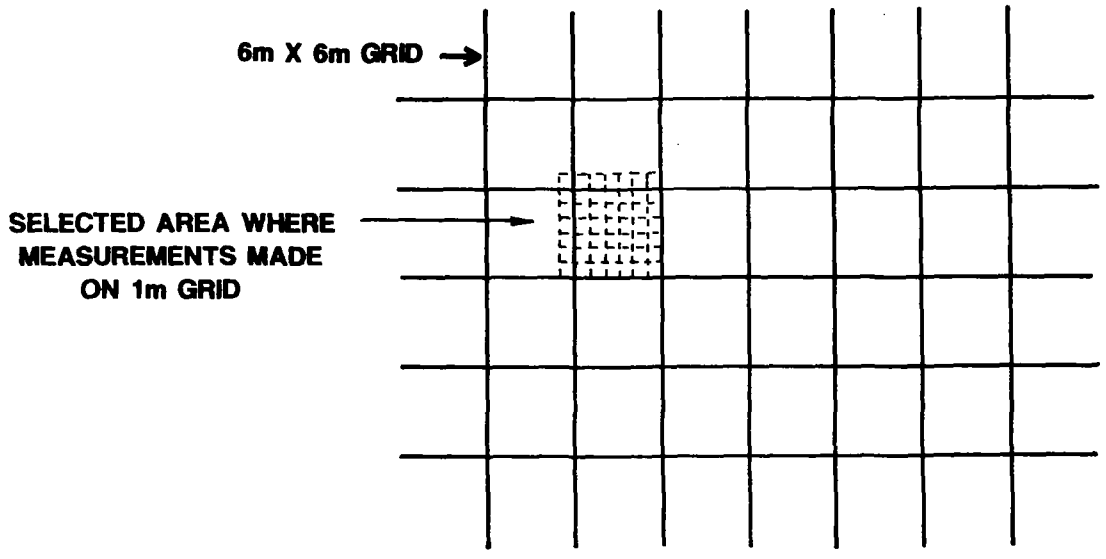


STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

316 E. ILLINOIS LOCATION MAP
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-22-94
CHECKED BY		
APPROVED BY	STN	2-22-94
SCALE: NTS	FIGURE NO.: 1-3	
STS DRAWING NO.: 27313-ZH		



STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

EXAMPLE OF RADIATION MONITORING GRIDS
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-22-94
CHECKED BY		
APPROVED BY	STN	2-22-94
SCALE: NTS	FIGURE NO.: 3-1	
STS DRAWING NO.: 27313-ZH		

Thorium Series (4n)*

Nuclide	Historical name	Half-life	Major radiation energies (MeV) and intensities†		
			α	β	γ
$^{232}_{90}Th$	Thorium	$1.41X10^{10}y$	3.95 (24%) 4.01 (76%)	---	---
$^{228}_{88}Ra$	Mesothorium I	5.75y	---	0.055 (100%)	---
$^{228}_{89}Ac$	Mesothorium II	6.13h	---	1.18 (35%) 1.75 (12%) 2.09 (12%)	0.34c‡ (15%) 0.908 (25%) 0.96c (20%)
$^{228}_{90}Th$	Radiothorium	1.910y	5.34 (28%) 5.43 (71%)	---	0.084 (1.6%) 0.214 (0.3%)
$^{224}_{88}Ra$	Thorium X	3.64d	5.45 (6%) 5.68 (94%)	---	0.241 (3.7%)
$^{220}_{86}Rn$	Emanation Thoron (Tn)	55s	6.29 (100%)	---	0.55 (0.07%)
$^{216}_{84}Po$	Thorium A	0.15s	6.78 (100%)	---	---
$^{212}_{82}Pb$	Thorium B	10.64h	---	0.346 (81%) 0.586 (14%)	0.239 (47%) 0.300 (3.2%)
$^{212}_{83}Bi$	Thorium C	60.6m	6.05 (25%) 6.09 (10%)	1.55 (5%) 2.26 (55%)	0.040 (2%) 0.727 (7%) 1.620 (1.8%)
64.0% / 36.0%					
$^{212}_{84}Po$	Thorium C'	304ns	8.78 (100%)	---	---
$^{208}_{81}Tl$	Thorium C''	3.10m	---	1.28 (25%) 1.52 (21%) 1.80 (50%)	0.511 (23%) 0.583 (86%) 0.860 (12%) 2.614 (100%)
$^{208}_{82}Pb$	Thorium D	Stable	---	---	---

*This expression describes the mass number of any member in this series, where n is an integer.
Example: $^{232}_{90}Th$ (4n).....4(58) = 232

†Intensities refer to percentage of disintegrations of the nuclide itself, not to original parent of series.

‡Complex energy peak which would be incompletely resolved by instruments of moderately low resolving power such as scintillators.

Data taken from: Lederer, C. M., Hollander, J. M., and Perlman, I., Table of Isotopes (6th ed.; New York: John Wiley & Sons, Inc., 1967) and Hogan, O. H., Zigman, P. E., and Mackin, J. L., Beta Spectra (USNRDL-TR-802 [Washington, D.C.: U.S. Atomic Energy Commission, 1964]).

STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

THORIUM DECAY CHAIN
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-22-94
CHECKED BY		
APPROVED BY	STN	2-22-94
SCALE: NTS	FIGURE NO.: 3-2	
STS DRAWING NO.: 27313-ZH		

Uranium Series (4n + 2)*

Nuclide	Historical name	Half-life	Major radiation energies (MeV) and intensities† α	β	γ
$^{238}_{92}U$	Uranium I	4.51×10^{9}y	4.15 (25%) 4.20 (75%)	---	---
$^{234}_{90}Th$	Uranium X_1	24.1d	---	0.103 (21%) 0.193 (79%)	0.063c‡ (3.5%) 0.093c (4%)
$^{234m}_{91}Pa$	Uranium X_2	1.17m	---	2.29 (98%)	0.765 (0.30%) 1.001 (0.60%)
99.87% | 0.13% → $^{234}_{91}Pa$	Uranium Z	6.75h	---	0.53 (66%) 1.13 (13%)	0.100 (50%) 0.70 (24%) 0.90 (70%)
$^{234}_{92}U$	Uranium II	2.47×10^{5}y	4.72 (28%) 4.77 (72%)	---	0.053 (0.2%)
$^{230}_{90}Th$	Ionium	8.0×10^{4}y	4.62 (24%) 4.68 (76%)	---	0.068 (0.6%) 0.142 (0.07%)
$^{226}_{88}Ra$	Radium	1602y	4.60 (6%) 4.78 (95%)	---	0.186 (4%)
$^{222}_{86}Rn$	Emanation Radon (Rn)	3.823d	5.49 (100%)	---	0.510 (0.07%)
$^{218}_{84}Po$	Radium A	3.05m	6.00 (~100%)	0.33 (~0.019%)	---
99.98% | 0.02% → $^{214}_{82}Pb$	Radium B	26.8m	---	0.65 (50%) 0.71 (40%) 0.98 (6%)	0.295 (19%) 0.352 (36%)
$^{218}_{85}At$	Astatine	~2s	6.65 (6%) 6.70 (94%)	? (~0.1%)	---
$^{214}_{83}Bi$	Radium C	19.7m	5.45 (0.012%) 5.51 (0.008%)	1.0 (23%) 1.51 (40%) 3.26 (19%)	0.609 (47%) 1.120 (17%) 1.764 (17%)
99.98% | 0.02% → $^{214}_{84}Po$	Radium C'	164μs	7.69 (100%)	---	0.799 (0.014%)
$^{210}_{81}Tl$	Radium C"	1.3m	---	1.3 (25%) 1.9 (56%) 2.3 (19%)	0.296 (80%) 0.795 (100%) 1.31 (21%)
$^{210}_{82}Pb$	Radium D	21y	3.72 (.000002%)	0.016 (85%) 0.061 (15%)	0.047 (4%)
$^{210}_{83}Bi$	Radium E	5.01d	4.65 (.00007%) 4.69 (.00005%)	1.161 (~100%)	---
~100% | .00013% → $^{210}_{84}Po$	Radium F	138.4d	5.305 (100%)	---	0.803 (0.0011%)
$^{206}_{81}Tl$	Radium E"	4.19m	---	1.571 (100%)	---
$^{206}_{82}Pb$	Radium G	Stable	---	---	---

*This expression describes the mass number of any member in this series, where n is an integer.
Example: $^{206}_{82}Pb$ (4n + 2).....4(51) + 2 = 206

†Intensities refer to percentage of disintegrations of the nuclide itself, not to original parent of series.

‡Complex energy peak which would be incompletely resolved by instruments of moderately low resolving power such as scintillators.

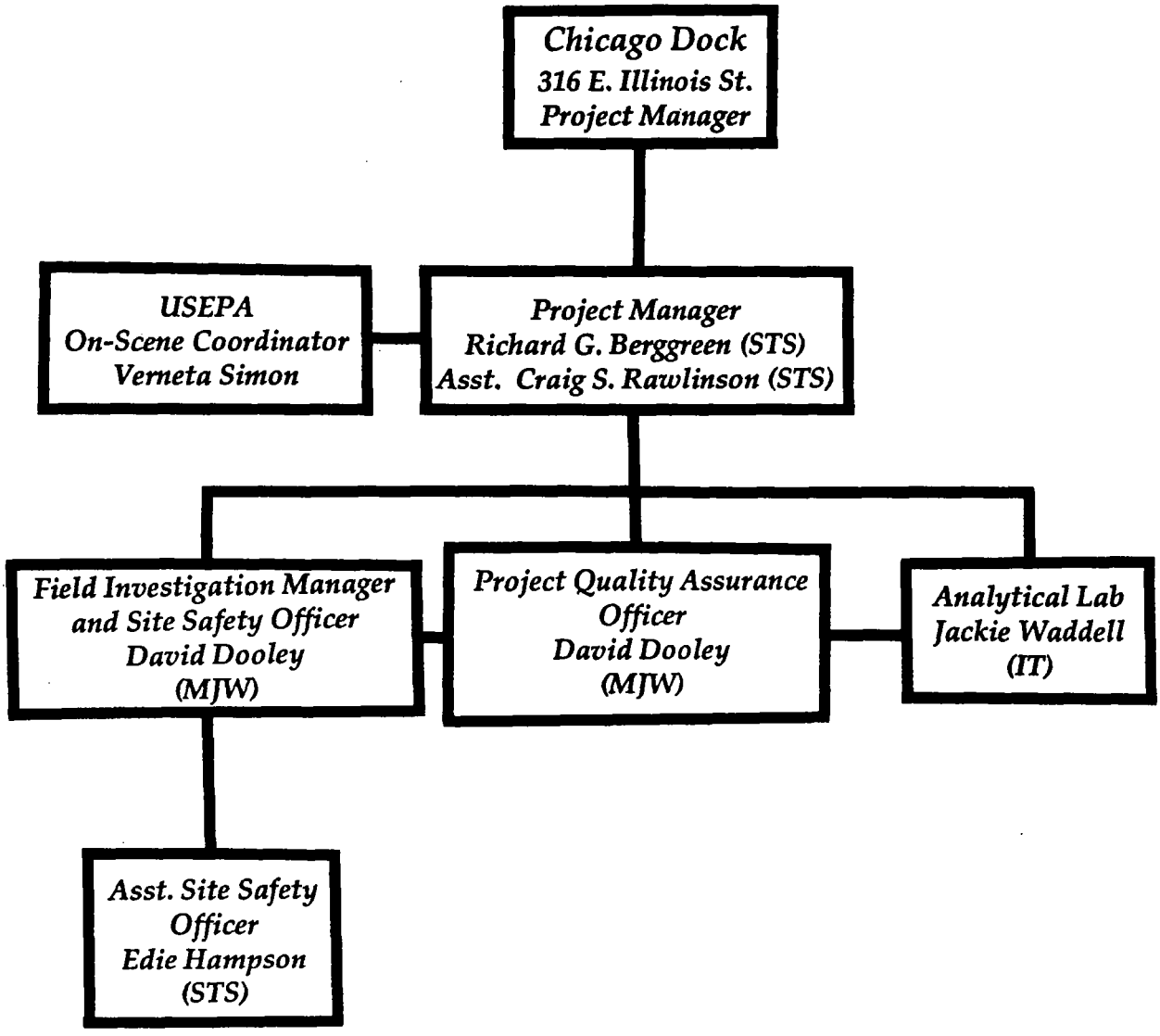
Data taken from: Table of Isotopes and USNRDL-TR-802.

STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

URANIUM DECAY CHAIN
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-22-94
CHECKED BY		
APPROVED BY	STN	2-22-94
SCALE: NTS	FIGURE NO.: 3-3	
STS DRAWING NO.: 27313-ZH		



STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

PROJECT MANAGEMENT ORGANIZATION
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-23-94
CHECKED BY		
APPROVED BY	STN	2-23-94
SCALE: NTS	FIGURE NO.: 6-1	
STS DRAWING NO.: 27313-ZH		

WORK PLAN CHANGE REQUEST FORM

Change No. _____ (Copy to Work Plan Margin as (#).)

Initiator Name: _____	Date: _____	Time: _____

DESCRIPTION OF CHANGE:

REASON FOR CHANGE:

IMPACT OF CHANGE:

APPROVED:

Project Coordinator: _____ Date: _____

EPA On-Scene Coordinator: _____ Date: _____

LIST OF TABLES

Table 3-1
Number of Samples and Analytical Techniques

		Samples	QA/QC Samples		
Analysis	Method	Soil	QA Spikes	Duplicates	Total Analysis
TCLP	SW846/1311 [8240,8270,6010,7000]	2	--	--	2
Corrosivity	EPA 9045	2	--	--	2
Ignitability	EPA 1010	2	--	--	2
Reactivity	EPA 9010/9030	2	--	--	2
Organic Carbon	EPA 9060	4	--	--	4
Rad Chem					
Isotopic U & Isotopic Th	IT 7231 IT 7103	3*	--	--	3
Gamma Spec**					
U & Th + D RA-226/228	IT 7212	10	2	2	14
	SUBTOTALS	**25**	**2**	**2**	**29**

* Three samples exhibiting the highest gamma spec readings will be selected for isotopic Uranium and isotopic Thorium analysis.
** All radionuclides found will be reported, whether in the U or Th decay series or not.

CDock:AA5:seb

Table 3-2
Sampling and Analysis Plan for Boring 1 (High Exposure)

Samples					
#1-A	#1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
RCRA Characteristics					
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
x	-	Corrosivity	EPA 9045	250 ml jar	14 days
x	-	Ignitibility	EPA 1010	Use Corros. jar	14 days
x	-	Reactivity	EPA 9010/9030	Use Corros. jar	14 days
x	-	Organic Carbon	EPA 9060	2 oz. glass	28 days
Rad Chem					
x	x	Isotopic U & Isotopic Th	IT 7231 IT 7103	1 liter jar	6 mo.
Gamma Spec					
x	x	U & Th + D RA-226/228	IT 7212	Zip Lk Bag 300 g	6 mo.

STN:AL3:seb

Table 3-3
Sampling and Analysis Plan for Boring 2 (High Exposure)

Samples #1-A	Samples #1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
RCRA Characteristics					
x	-	TCLP	1311;8240,8270,6010,7000	250 ml Brown Jar Teflon Seal	7/40 days
x	-	Corrosivity	EPA 9045	250 ml Jar	14 days
x	-	Ignitibility	EPA 1010	Use Corros. Jar	14 days
x	-	Reactivity	EPA 9010/9030	Use Corros. Jar	14 days
x	-	Organic Carbon	EPA 9060	2 oz. glass	28 days
Rad Chem					
x	-	Isotopic U & Isotopic Th	IT 7231 IT 7103	1 liter Jar	6 mo.
Gamma Spec					
x	x	U & Th + D RA-226/228	IT 7212	Zip Lk Bag 300 g	6 mo.

STN:AL3:seb

Table 3-4
Sampling and Analysis Plan for Boring 3, Near Booth

Samples					
#1-A	#1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	Organic Carbon	EPA 9060	2 oz. glass	28 days
Gamma Spec					
x	x	U & Th + D RA-226/228	IT 7212	Zip Lk Bag 300 g	6 mo.

STN:AL3:seb

Table 3-5
Sampling and Analysis Plan for Boring 4

Samples					
#1-A	#1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
x	-	Organic Carbon	EPA 9060	2 oz. glass	28 days
Gamma Spec					
x	x	U & Th + D RA-226/228	IT 7212	Zip Lk Bag 300 g	6 mo.

STN:AL3:seb

Table 3-6
Sampling and Analysis Plan for Boring 5, Background Location

Samples					
#1-A	#1-B	Analysis	Analytical Method	Sample Container Soil	Holding Time
Gamma Spec					
x	x	U & Th + D RA-226/228	 IT 7212	Zip Lk Bag 300 g	6 mo.

STN:AL3:seb

Table 3-7
Sampling and Analysis Plan for Four Monitoring Wells

Samples	Analysis	Analytical Method	Sample Container Soil	Holding Time
4-wells	Radiochemistry U isotopic	EPA 908.0	11 plastic	30 days
4-wells	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
4-wells	SDWA Metals	EPA 6010/7000	1-liter plastic	6 mo.
QA Samples				
Trip Blank	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
	SDWA Metals	EPA 6010/7000	2-liter plastic	6 mo.
QA Blind Blank	U isotopic	EPA 908.0	11 plastic	30 days
	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
	SDWA Metals	EPA 6010/7000	1-liter plastic	6 mo.
Field Blank	U isotopic	EPA 908.0	11 plastic	30 days
	Ra-226&228	EPA 903.1 EPA 904.0 mod	2-liter plastic or 2 1-liter	30 days
	SDWA Metals	EPA 6010/7000	1-liter	6 mo.

- Lab to add preservative to all containers prior to shipping.
- All samples from wells filtered in field.
- A duplicate sample will be submitted from one of the four wells.

STN:AL3:seb

ATTACHMENT A

M.J.W. Corporation Inc.

RADIOLOGICAL CONTROL PROCEDURE 40

Controlled Copy Number _____

CONDUCT OF OVERLAND GAMMA SURVEYS

1.0 PURPOSE

The purpose of this procedure is to delineate protocols and data required to perform low-level radiation overland gamma surveys.

2.0 SCOPE

This procedure is applicable for general or discrete radiation surveys intended to measure direct radiation and/or contamination levels of areas expected to be at or near background levels.

3.0 RESPONSIBILITIES

3.1 All survey instruments used to determine direct radiation levels or contamination levels shall have been calibrated within six months prior to the survey.

3.2 Surveys shall be performed in accordance with all applicable standards as listed in Section 6.0.

3.3 Persons performing the survey shall be responsible for proper instrument checks and operation, properly recorded measurements, and map per Section 4.0 of this procedure.

4.0 PROCEDURE

4.1 Equipment List

- Surveying and staking materials
- Bicron microRem LE (or equivalent)
- ESP-1 with Ludlum 44-10 (or equivalent)
- Area maps as appropriate
- Mason's line marked at designated intervals
- Panoramic 470A ion chamber (or equivalent)
- Ludlum 44-10 Collimator

4.0 PROCEDURE (Continued)

4.1 Equipment List (continued)

- Miscellaneous marking and recording equipment
- 100 foot tape measure
- Protective clothing as appropriate
- Smears (1 box)

4.2 MEASUREMENT PROTOCOLS

4.2.1 Perform a battery check, source check and calibration data check prior to use of survey instrument per the requirements of Section 3.0.

4.2.2 At a location known to be free of contamination, make several background measurements, recording data, time, survey instrument serial number, surveyor and general survey area location. Use Form RCP 40-1 to record this data.

4.2.3 Establish the primary reference point for the survey and any second reference points required to adequately describe the site and allow for creation and recreation of the survey grid. The reference point shall be designated as point A-0 or equivalent with magnetic north indicated clearly in reference to point A-0.

4.2.4 From the primary and any secondary reference points, establish area survey points using stakes and marked string lines at the predetermined survey interval. All other grid locations will be designed in alphanumeric sequence from the reference point. Use Form RCP 40-2 to show survey grid, detailing the primary reference point, any secondary points, landmarks and grid spacing.

NOTE: Grid pattern spacing should be no more than fifteen (15) feet apart for complete coverage. Minimum detectable activity will be dependent upon background levels and instrument efficiencies. Decreasing the grid spacing will give higher detection probability for low activity of diffuse sources.

For a uniformly distributed Co-60 source the predicted exposure rate at one meter above the surface in 5.79 E-04 Sv/yr per Bg/cm^2 (NUREG/CR-1918). This translates to 43.2 microR/hr per uCi/m^2.

4.2 MEASUREMENT PROTOCOLS (Continued)

4.2.5 Measure the gamma radiation level at the reference location at a distance of one meter (approximately waist height) and at one centimeter from the ground surface. CAUTION: Survey instruments must not come into contact with any potentially contaminated surfaces.

4.2.6 Record measurements from designated survey locations on Forms RCP 40-3 and 3A, including alphanumeric survey location, gamma radiation readings at 1 meter and 1 cm and any remarks for the location. Complete the top of each form with the following data: job number, date, surveyor and instrument data.

4.2.7 Proceed at a slow pace (approximately one foot per second) to the next survey point, continually checking the instrument readout for any strong fluctuations.

4.2.8 If strong fluctuations are encountered, use readings taken from a distance of one centimeter to define the area of the increased activity. Use spray paint, string or other method to mark areas of elevated activity and also mark the location of this area on Form RCP 40-2 using colored markers.

4.2.9 After all initial survey points have been recorded, return to any areas of elevated readings. Perform a detailed survey to define the areas and note the upper limits of the measurements using one of the following methods: (document all results on Forms RCP 40-4 and 4A).

- Using concentric circles, define the center and then the radius of contamination and record this on the survey form, or

- Using a small-spaced grid pattern of 1 meter or less, find the center and general outline of the contamination and record on the survey form, RCP40-4 or 4A as appropriate.

NOTE: Per step 4.2.8 use spray paint, string or other suitable medium to define the physical limits of the contamination/radiation. Use standard precautions to avoid personal or equipment contamination during the survey.

4.2.10 Check the survey map for complete coverage. Notify the appropriate client personnel if immediate posting or cleanup actions may be required.

4.2.11 Remove all nonpermanent markers and stakes unless further action is to be taken. Monitor all materials for potential radioactive contamination before removal from any areas of suspected or confirmed contamination.

4.3 INSTRUMENT CALIBRATION

4.3.1 All instruments shall be calibrated annually and shall have a valid calibration sticker at the time of use.

4.3.2 Instruments will be taggged "out of service" for :

- failure to properly respond to check sources, or
- instrument damage, or
- suspect operation of the instrument

Any instrument tagged "out of service" shall be repaired or replaced and shall be recalibrated before use.

5.0 DEFINITIONS

None

6.0 REFERENCES

6.1 National Council on Radiation Protection and Measurements, NCRP Report No. 50, "Environmental Radiation Measurements", December 1976.

6.2 National Council on Radiation Protection and Measurements, NCRP Report No. 58, "A Handbook of Radioactivity Measurements Procedures", 2nd Ed., 1985

6.3 Kocher, D.C., 1979, "Dose-Rate Conversion Factors for External Exposure to Photons and Electrons", NUREG/CR-1918.

7.0 ATTACHMENTS

Attachment 1 - Background Radiation Survey Data Sheet, Form RCP 40-1

Attachment 2 - Low Level Radiation Survey Map, Form RCP 40-2

Attachment 3 - Radiation Survey Data Sheet, Form RCP 40-3

Attachment 4 - Radiation Survey Data Continuation Sheet, Form RCP 40-3A

Attachment 5 - Detailed Area Survey Sheet, Form RCP 40-4

Attachment 6 - Detailed Area Survey Map, Form RCP 40-4A

M.J.W. Corporation Inc.

BACKGROUND RADIATION SURVEY DATA SHEET
FORM RCP 40-1

Client: _____	Job No: _____
Surveyor: _____	Date: _____

Instrument Model: _____ Serial # _____ Units _____ Bkg. _____ Cal. Date _____

Instrument Model: _____ Serial # _____ Units _____ Bkg. _____ Cal. Date _____

Instrument Model: _____ Serial # _____ Units _____ Bkg. _____ Cal. Date _____

Survey Instrument	Measurement Location	Direct Reading @ 1 m*	Direct Reading @ 1 cm*	Remarks

*Note: All radiation readings will be made in the same units noted for the instrument unless otherwise noted in the remarks column.

M.J.W. Corporation Inc.

LOW LEVEL RADIATION SURVEY MAP

FORM RCP 40-2

Client: _____	Job No: _____
Work Description: _____	

INDICATE NORTH

MEASUREMENT UNITS: _____	DATA RECORDED BY: _____ DATE: _____
DRAWING SCALE: _____	CHECKED BY: _____ DATE: _____

M.J.W. Corporation Inc.

RADIATION SURVEY DATA SHEET
FORM RCP 40-3

Client: _____ Job No: _____

Surveyor: _____ Date: _____

Instrument Model: _____ Serial # _____ Units _____ Bkg. _____ Cal. Date _____

Instrument Model: _____ Serial # _____ Units _____ Bkg. _____ Cal. Date _____

Instrument Model: _____ Serial # _____ Units _____ Bkg. _____ Cal. Date _____

Survey Location	Instrument Number	Direct Reading @ 1m*	Direct Reading @ 1 cm*	Remarks

*Note: All radiation readings will be made in the same units noted for the instrument unless otherwise noted in the remarks column.

M.J.W. Corporation Inc.

RADIATION SURVEY DATA CONTINUATION SHEET
FORM RCP 40-3A

Client: _____ Job No: _____

Surveyor: _____ Date: _____

Survey Location	Instrument Number	Direct Reading @ 1m*	Direct Reading @ 1 cm*	Remarks

*Note: All radiation readings will be made in the same units noted for the instrument unless otherwise noted in the remarks column.

M.J.W. Corporation Inc.

DETAILED AREA SURVEY SHEET

FORM RCP 40-4

Client: ________________________ Job No: ________________________

Surveyor: ________________________ Date: ________________________

Survey Instrument 1: __________ Serial # ______________ Units ________ Bkg. (ave.)______ Cal. Date __________

Survey Instrument 2: __________ Serial # ______________ Units ________ Bkg. (ave.)______ Cal. Date __________

Survey Instrument 3: __________ Serial # ______________ Units ________ Bkg. (ave) ______ Cal. Date __________

Survey Location	Instrument Number	Direct Reading @ 1 m*	Direct Reading @ 1 cm*	Beta Readings @ 1 cm		Remarks
				OPEN	CLOSED	

*Note: All radiation readings will be made in the same units noted for the instrument unless otherwise noted in the remarks column.

M.J.W. Corporation Inc.

DETAILED AREA SURVEY MAP*

FORM RCP 40-4A

Client: _____ Job No: _____

Work Description: _____

INDICATE NORTH

*Refer to Form RCP40-2 for general area survey details.

MEASUREMENT UNITS: _____ DATA RECORDED BY: _____ DATE: _____

DRAWING SCALE: _____ CHECKED BY: _____ DATE: _____

ATTACHMENT B

M.J.W. Corporation Inc.

RADIOLOGICAL PROCEDURE RP-41

Controlled Copy Number _____

OPERATING INSTRUCTIONS FOR THE BICRON MICRO REM TISSUE EQUIVALENT SURVEY METER

1.0 PURPOSE

This procedure presents the operating instructions for the Bicron MICRO REM tissue equivalent survey meter.

2.0 SCOPE

The Bicron MICRO REM survey meter gives tissue equivalent dose-rate readings for photons from 17 kev (with low energy option) to 1.2 MeV. The response range of the instrument is 0-200 mrem/hr full scale. All instrument functions are selected via a single control switch.

3.0 RESPONSIBILITIES

3.1 The site Safety Officer, or designated alternate, shall ensure that the MICRO REM is maintained functional and calibrated.

3.2 The site Safety Officer shall ensure that maintenance and calibrations are performed.

3.3 The Health Physics Technician shall ensure that the MICRO REM is operated in accordance with this procedure.

3.4 Personnel authorized to use the MICRO REM shall comply with this procedure. If the instrument fails any operability checks, is out of calibration, or functions erratically, it shall be taken out of service and returned to the site Safety Officer for repair/calibration.

4.0 GENERAL

4.1 Regardless of the Bicrons' rugged appearance, it is a delicate instrument and should be handled with care at all times.

5.0 PROCEDURE

5.1 Preoperational Checks

5.1.1 Battery Check: Turn the control switch to the "bat." position. The meter needle should deflect into the "bat. ok" checkband. If the meter needle does not deflect into the "bat. ok" checkband, replace the batteries as described in Section 5.1.2. Record all preoperational check data on Form RP 41-1.

5.1.2 Battery Replacement:

5.1.2.1 Turn instrument off.

5.1.2.2 Open pull catches at ends of case and separate case bottom from top.

5.1.2.3 Install batteries (two 9 Volt MN1604 or equivalent) in clips on bottom circuit board, observe proper polarity. Both batteries should be replaced at the same time.

5.1.2.4 Replace the case bottom, orienting the rubber pad under the batteries. Close catches.

5.1.2.5 Repeat battery check per Section 5.1.1.

5.1.3 High Voltage Check: Turn the control switch to the "HV" position. The meter needle should deflect into the "HV OK" checkband. If the meter needle does not deflect into the "HV OK" checkband, remove the instrument from service and return it to the Environmental Engineer for repair/calibration.

5.1.4 Range selection and response time: The MICRO REM has five linear ranges, shown in Table 1, below. These range from 0-20 µrem/hr at the low end, to 0-200 mrem/hr at the high end. Note that the meter contains a linear scale from 0-200 µrem/hr. The actual dose-rate is obtained by multiplying the meter reading and the range selector value.

TABLE 1

Range Selector Value	Dose Rate Range	Response Time
x 0.1	0-20 µrem/hr	15 sec.
x 1.0	0-200 µrem/hr	15 sec.
x 10	0-2 mrem/hr	5 sec.
x 100	0-20 mrem/hr	2 sec.
x 1000	0-200 mrem/hr	2 sec.

In order to measure very low dose rates (0-20 µrem/hr) the instrument must be held in the desired location for at least 15 sec. The column entitled "Response Time" in Table 1 above lists the time required for the instrument to give an accurate measurement of the dose-rate. Be sure to follow these times when using this instrument for field measurements.

5.1.5 Source Response Check: After performing Steps 5.1.1 and 5.1.3 above, the instrument must be checked for response to a known radiation source.

5.1.5.1 Set range selector switch to appropriate setting for the radiation check source to be used.

5.1.5.2 Place the instrument in the radiation field and wait the required time for the range selected. Verify that the instrument displays a dose rate within the acceptable range. If an unacceptable dose rate is obtained, tag the instrument out of service and return it to the site Safety Officer.

5.1.5.3 Source checks shall be performed before each instruments use and at the end of use for each day. source checks will typically be performed using a Cs-137 standard, but other sources may be substituted as appropriate. Source check data should be plotted daily on appropriate control charts.

5.1.6 Calibration Check: Verify that a valid calibration sticker is affixed to the instrument. If the calibration has expired, or the sticker is missing, tag the instrument out of service and return it to the site Safety Officer for calibration.

5.1.7 If the instrument passed all tests in Section 5.1, it is ready for field operation.

5.2 Field Operation

5.2.1 Perform pre-operational checks as described in Section 5.1 above and record all required data on Form RP 41-1.

5.2.2 Turn the alarm switch on or off as desired (if present on the instrument).

5.2.3 The instrument normally responds to x-ray and gamma photons from 40 keV to 1.2 MeV. A low energy option (Microrem LE) increases the sensitivity down to 17 keV.

5.2.4 If entering an area with unknown dose rates, set the range selector switch on the highest setting (X 1000) before entering the area. Enter the area and take initial measurements, holding the instrument in a given location at least 2 seconds. If no reading is obtained on the highest range, switch to the next lower range and repeat the measurement. Continue this process until an upscale reading is obtained. Note: As the range is lowered, the response time of the instrument increases, necessitating longer survey times at each location. Refer to Table 1 for instrument response times for the various ranges.

5.2.5 Care should be taken not to contaminate the instrument. Place the instrument in a plastic bag if significant loose surface contamination is present.

5.2.6 Avoid dropping the instrument, or subjecting it to severe shock.

5.2.7 If the instrument malfunctions during use, or displays erratic readings, leave the area, tag the instrument out of service and return it to the site Safety Officer for repair/calibration.

5.3 Calibration and Maintenance

5.3.1 The site Safety Officer is responsible to assure that all instruments are calibrated by the vendor or other qualified company every six months. The instrument shall be recalibrated after the conduct of maintenance, with the exception of a simple battery change.

5.3.2 A calibration sticker shall be affixed to each instrument indicating the date of calibration and the calibration due date. The calibration facility shall calibrate all operating ranges according to the manufacturer's instructions, and record "as found" and "as left" conditions for each range.

5.3.3 The site Safety Officer shall maintain all instrument calibration records in a separate file for the life of the plant or 75 years, whichever is longer.

6.0 REFERENCES

6.1 Technical Manual: MICRO REM Tissue Equivalent Survey Meter, 1987, Bicron Corporation.

6.2 ANSI 323-1978, Radiation Protection Instrumentation Test and Calibration.

7.0 ATTACHMENTS

7.1 Form RP 41-1 - Instrument Field Source Check Form

M.J.W. Corporation Inc.

INSTRUMENT FIELD SOURCE CHECK FORM
FORM RCP 41-1

Instrument Make/Model: _____ Serial Number: _____

Date															
Battery Check (*sat/unsat*)															
Calibration Label present (y/n)															
*Calibration Due Date															
Probe Type: Serial Number:															
Probe Calibrated with Inst. (y/n)															
Date of Last *Plateau*															
H.V. Setting															
Source Nuclide & Serial Number															
Source Activity (dpm)															
Source cpm															
Bkg															
% Efficiency (cpm/dpm)															
Correction Factor															
Tech. Initials															

*DO NOT use instrument if past calibration due date

ATTACHMENT C

STS CONSULTANTS, LTD.

RADIOLOGICAL CONTROL PROCEDURE

Controlled Copy _____

CALIBRATION PROCEDURE FOR CONE PENETROMETER TEST (CPT) TRUCK GAMMA LOGGER

1.0 PURPOSE

This procedure establishes the methods required to calibrate the CPT gamma logger to a known homogeneous radioactive soil source in the standard measurement geometries.

2.0 SCOPE

The procedure only applies to the COLOG MXG gamma logger with the 0.5" x 1.5" NaI (Tl) detector, taking into account potential signal loss based on cable length.

3.0 RESPONSIBILITIES

3.1 The STS Project Manager will be responsible to assure that calibrations are performed in a timely and accurate manner and for proper documentation and retention of calibration records.

3.2 The Site Safety Officer will be responsible to assure that the calibrations performed are appropriate for the radioactive species to be measured and that the calibration is a minimum 2 point calibration which covers the expected range of nuclide concentrations to be encountered in the field.

3.3 The Task Leader shall ensure that the calibrations are properly performed and documented.

4.0 GENERAL

This procedure should follow all manufacturers' recommendations with regard to calibration. See reference _____.

Approved:_____ Effective:_____
Health Physics Director

5.0 PROCEDURE

5.1 Instrument Source Check

If not already built into the unit, the gamma logger detector response to radiation will be checked with a known gamma source. The gamma logger detector should provide a steady upscale reading for as long as the source is in the vicinity of the detector. The detector response should be similar each time it is checked with the same source and corresponds to manufacturers recommended limits. Source checks shall be performed at the beginning and the end of each operation and the results plotted on appropriate control charts.

5.2 Check Base Station Boring

To verify the replicability of the instrument response, a base station consisting of a CPT boring will be logged at the start and finish of the downhole geophysical program.

5.3 Soil Calibration

5.3.1 Geometry Considerations

Because the gamma logger is used to measure radiation present in situ the calibration must also be performed under similar geometrical conditions. To this end, a 55 gallon drum of a known soil concentration is prepared such that the gamma logger can be placed in the drum under identical circumstances for each test. Repeatable geometry then allows for reproducible calibration results.

5.3.2 Specific Source Matrics

The calibration sources will be made up of thorium in a stable chemical form which is homogeneously mixed in a dry soil matrix. The thorium concentrations of each calibration source will be varied in accordance with the specific objectives of the calibration. In no instance shall the calibration be less than two points.

5.3.3 Data Collection

Calibration data will be recorded on Attachment 1. All information requested on Attachment 1 should be completed to insure that the calibration can be repeated in the future under identical conditions. Certificates of calibration for the sources used should also be made part of the record.

5.3.4 Documentation of Results

All records associated with the gamma logger calibrations shall be maintained in a calibration notebook and made part of any report(s) which have gamma logging data as part of the investigative effort.

6.0 QUALITY ASSURANCE

Quality Assurance will be maintained under the QAPP. Calibration documentation will required 100% QA verification prior to formal acceptance of the data.

7.0 REFERENCES

7.1 Mount Sopris COLOG MXG User's Manual, (date).

8.0 ATTACHMENTS

8.1 Attachment 1 - CPT Gamma Logger Calibration Data Sheet

ATTACHMENT D

STS CONSULTANTS, LTD.

RADIOLOGICAL CONTROL PROCEDURE

Controlled Copy ___

GAMMA LOGGING BOREHOLES TO DETERMINE THE CONCENTRATION OF RA-226 AND OTHER GAMMA EMITTING RADIONUCLIDES

1.0 PURPOSE

This procedure is used to gamma log (survey) boreholes to determine the concentration of radionuclides in the soil adjoining the borehole. The procedure is based on using calibration factors from prior experience, theoretical calibration factors, or factors developed from the analysis of samples from the boreholes. Where, the calibration factor relates the soil nuclide concentration in pCi/g to the counts per second (or unit time) recorded by the logging unit.

2.0 SCOPE

The procedure is used to determine the vertical profile of radionuclides in sub-surface soil. The method primarily detects radionuclides within about a one foot diameter (6" radius) of the borehole, due to the attenuation of gamma radiation in the soil. The basic procedure is similar to that commonly used to characterize the sub-surface environment when drilling wells. It is common to make measurements of the gamma emissions in wells to determine changes in the geologic stratigraphy, based on the different concentrations of naturally occurring uranium, thorium and potassium in different formations.

This procedure applies the concepts of gamma logging of borings to obtain the concentrations of radionuclides present in the formations, and minimize the need for detailed sampling. A calibration plot is made of gamma count rate versus the concentration(s) of the subject radionuclides in selected samples taken from the borings. The calibration plot can be obtained from laboratory analysis of samples from the site being studied or derived by other means. The objective is to obtain extensive information on the vertical distribution of the subject radionuclides without having to obtain samples from the full vertical profile for all borings.

Approved:_____ Effective:_____
Health Physics Director

3.0 RESPONSIBILITIES

The Task Leader performing the work is responsible for obtaining properly calibrated instruments and using field check sources to verify the instruments are operating correctly.

The Project Manager or designee shall provide overview of the operations and review the field data. The Project Manager shall provide the specifications concerning the depth increments for making measurements and the required statistical accuracy(i.e., counting time and the associated counting error) for the project.

The QA Officer shall audit the procedures and results to determine proper QA procedures have been used.

4.0 PROCEDURE

4.1 Equipment List

- Electronic scaler for providing integral counts of detected radiation. The instrument shall be a COLOG MXG logger or equivalent.
- Radiation detector: Mount Sopris Model HLP-2375-I 0.5" x 1.5" NaI(Tl) detector.
- Printer for scaler readout, if applicable.
- High voltage cables for detectors, with a sufficient length for down-hole measurements.
- Field check source to ensure proper operation of the system.
- Cable or cord with measured increments for determining the position of the detector in the boring.
- PVC casing for the boring, with an inside diameter sufficiently large for insertion of the radiation detector.
- Bound log book for recording information.
- Tape recorder, optional for recording supplemental or back-up information.
- Computer or calculator and appropriate software for reduction of data.
- Camera, optional, for documenting site operations.

4.2 Cone Penetrometer Test (CPT) Truck

The CPT truck unit comes equipped with a gamma logger to characterize

subsurface radiological emissions capable of penetrating the casing and causing an interaction in the sensitive volume of the detector. Typically.only nuclides with associated emissions of greater than 100 keV can be detected in the best of conditions (dry soil, no water in bore hole, etc.). The use of a steel casing typical of CPT units further complicates the issue by attenuating a significant portion of the low energy gamma rays emitted from naturally occuring radioactive material. The CPT gamma logger detector is put into the steel casing to the bottom of the boring and is methodically hoisted recording detector response over time and distance. This response can then be related to known geologic formations or to the presence of other subsurface readioactive material.

For the purpose of this investigation. the CPT rig will be calibrated in a known thorium soil matrix. This calibration, done with both a steel casing and P C will allow a quantitative estimate of subsurface thorium concentrations which may be associated with former Lindsay Light operations.

4.3 Casing of Boring

Borings may also be cased with PVC (preferably light schedule) prior to logging, or in stable formations it may not be necessary to case them. It is preferable that the casing be capped on the lower end to prevent the infusion of liquids, a cap is not needed. The specifications for the boring: e.g., whether it is cased, the type of casing, and whether liquids are present shall be recorded to allow adjusting the calibration factor to the specific conditions.

It is desirable that fluids not be present in the casing. since they will attenuate the radiation from the formation. If fluids are present. it shall be noted, and if possible special calibrations made for conversion of the detector signal to concentration of radioactivity.

4.4 Measurements

The detector (e.g., 0.5" x 1.5" NaI) shall be connected to the recording instrument (e.g., COLOG MXG) and checked with a check source to ensure proper calibration. The length of cable and reading of the check source shall be recorded to allow proper normalization of the data for different cables (e.g., long cables can degrade the signal from the detector for some instruments).

The detector shall be inserted in the boring and measurements made at the specified depth increments. Measurements are normally taken at 1 foot depth increments, but this may be adjusted based on the project specifications. The counting time shall be adjusted to ensure a minimum accumulation of 1000 counts, to provide a one-sigma statistical error of 3 percent (square root of counts) or less. The actual counting time shall be based on the specifications for the project. The counting time at different depths and the depth increments at which measurements are made can be adjusted to the observed results. All information shall be fully recorded to prevent misinterpretation of results.

4.5 Determination of Calibration Factor

The calibration factor is determined by comparing the gamma log values with samples taken from the associated sample depths. A least-squares analysis is performed with the gamma log values as "y" and the laboratory analytical values as "x". The correlation coefficient for the data shall be obtained. When possible, sufficient calibration points should be collected to obtain a correlation coefficient of 0.8 or higher. The degree of correlation will depend on the varying ratio of radionuclides in the formations (e.g., ratio of Ra-226 and variations in the amount of K-40), the elevation of concentrations of the radionuclides above average earth crust values of about 1 pCi/g (10 pCi/g for K-40) and variations in the density and moisture content of the geological strata.

5.0 DEFINITIONS

Calibration factor: pCi/g of subject radionuclide per count per second.

6.0 REFERENCES

COLOG MXG Gamma Logger Reference Manual, (No./Date)

7.0 ATTACHMENTS

Attachment 1 - CPT Gamma Logger Data Sheet

ATTACHMENT E


BOREHOLE GEOPHYSICS
COLOG
INC.
GOLDEN, COLORADO

GENERAL INFORMATION

The MGX digital logger consists of the following major components:

1. Motorized winch. (110 V or 220 V, see note at power switch)

2. Tripod assembly for ground and derrick operations.

3. Single conductor cable and cablehead. (200 m of 1/8" or 305 m of 1/10" cable)

4. Integrally mounted electronics console for probe power and control, serial data output, and winch control. (110/220 V) See power specification at power switch.

5. HLP-2375/S stratigraphic gamma/SP/single point resistance probe. Other probes may be supplied or substituted depending on customer requirements.

6. Mud plug, power cable, serial cable

7. Hand crank for emergency operation of winch.

8. High strength polyethylene cases for logger and probe/tripod.

9. LOGSHELL software for data acquisition and processing. Minimum hardware required 80286 CPU, 16 Mhz processor, 640K RAM, 20 Mb hard drive(3 Mb free), DOS 3.2 or higher and VGA graphics. Contact Mount Sopris for further information.

Shipping Containers

The durable polyethylene carrying cases are designed to protect the logger and probe under normal transport conditions. They will provide many years of reliable service if properly maintained. The probe case is not designed for shipping probes back to the factory for service. Re-use the sturdy cardboard case provided with the probe, as it has excellent centralized padding that will offer the best protection for long-distance shipping by common carrier.

When shipping the logger, store the tripod and its components, the probe, and the mud plug in the probe carrying case.

Always dry off the probe, tripod, and logger thoroughly before placing in the carrying cases, especially if they will be stored for a long time. The inside of the probe top and the cable head require extra care, and should be checked before installing the thread protector caps to be certain they are clean and dry.

Installing Software

MGX loggers purchased with computers will be shipped to the customer with the software installed in a sub-directory called PLOT. The user needs only to type the statement "LOGSHELL <CR>" to start the program.

Customers who wish to use their own computers will be furnished 3 installation disks and instructions on how to install the software on their machines. Instructions on how to configure the software for different graphics modes and printers are included with the software documentation.

Preparation Before Logging

Before setting up the logger, be sure that an adequate power supply of the proper voltage is available. Use only grounded power supply cables to operate the system. Set the logger up in a level dry location, keeping the computer and console controls out of bright sunlight if possible, to allow better viewing. Many portable PCs will not operate if the case temperature exceeds 40° C. (110° F.) This can easily occur if the PC is left in direct sunlight, **particularly if the PC has a dark case.**

Logging with a PC acquisition system requires that the user take extra care in setting up the unit to avoid moisture and excess dust and dirt. If reasonable care is taken, the PC will give good service for many years.

The tripod can be set up in a standard wellhead position or the

sheave assembly can be removed from the yoke and hung in the derrick with the included safety hook. Simply remove the two pins from the tripod head that hold the sheave, and replace attach to the hook with one of the pins. The wheel will have to be removed from the sheave so that the cable can be run over the inside of the sheave. Re-install the long pin through the wheel and sheave so that the cable can run over the top of the wheel when hung from the hook.

If resistivity or SP logging is to be performed, remove the mud plug and cable from the probe carrying case and insert the pin into the end of the console marked **MUD PLUG**. Place the lead electrode in the mud pit if possible. If not, dig a shallow hole, keep it full of water, and place lead electrode in hole. If in a very dry location, it may be necessary to drive a stake into the ground and clamp the lead electrode to the ground.

Since the logger will have a serial cable going to the computer, a mud plug cable going to the mud plug electrode, and a power cable going to the supply, keep all cables laid out in an orderly fashion to avoid tripping over them. The PC and printer will also have to be set up so that the cable are out of traffic.

Cable checks

Before proceeding, put the drive clutch in "disengage/manual crank" position. This is accomplished by grasping the knurled knob on the side of the logger and pulling it out and turning it a few degrees. This disengages the motor drive and allows the cable to be pulled out by hand or driven by the hand crank when the hand crank is attached to the square shaft immediately above the clutch knob. Pull out enough cable to allow the probe to be connected near the borehole and lifted over the sheave. Once this is done, re-engage the motor drive with the clutch knob by pulling knob out, turning back a few degrees and allowing it to reset in the motor drive sprocket. You may need to move the drum slightly to cause the drive to re-engage. Check the cable for insulation with an ohmmeter. The center pin on the cable head should be isolated from the armor or cable bulkhead by at least 20 megohms resistance. The center conductor can be checked for continuity by shorting the bulkhead or armor to the center pin and measuring between the armor and conductor pins on the end of the console. Cable resistance should be approximately 25 ohm-m/1000 ft (305 m) of cable. The mechanical and electrical properties of the cable are important to overall system performance and must be within acceptable limits for successful operation. If the cable or cablehead does not meet specifications, correct the problem before attempting to log.

HARDWARE SET-UP

(See figures A and B)

1. Connect Serial Port Cable between DB9 connector on the MGX to PC COM1 serial port.

2. Connect AC Power to Logger, PC and Printer

3. Connect Printer cable between Printer and PC

4. Turn on PC

5. Connect mud plug cable to MGX as noted above, if required.

If you purchased a PC through Mount Sopris, the software will be installed at the factory. To start the LOGSHELL program, simply type LOGSHELL <ENTER>. Refer to the software documentation for further instructions. **Remember, on screen HELP is available at any time, simply by pressing F1.**

If you are using your own PC with the MGX, it will be necessary for you to install the software.

Software Installation:

1. Locate the 3 disks labelled "LOGSHELL V X.XX". Place disk 1 in your 3.5" 1.44 Mb drive. Access your drive by typing A: or B: depending on its designation. Then type "Install <ENTER>" and follow the instructions. You will be asked to insert the other two disks in order. The disks should then be removed and the system re-booted. The program can be started by typing LOGSHELL <ENTER>. As with all software, it is a good idea to make a copy of the original installation disks and store the originals in a safe place. Normally it should not be necessary to re-install the program on the PC in the field, but it is suggested that you take a spare set of program disks with you when doing field work.

2. To configure the system to match your printer and probes, see the CONFIGURE section in the software documentation.

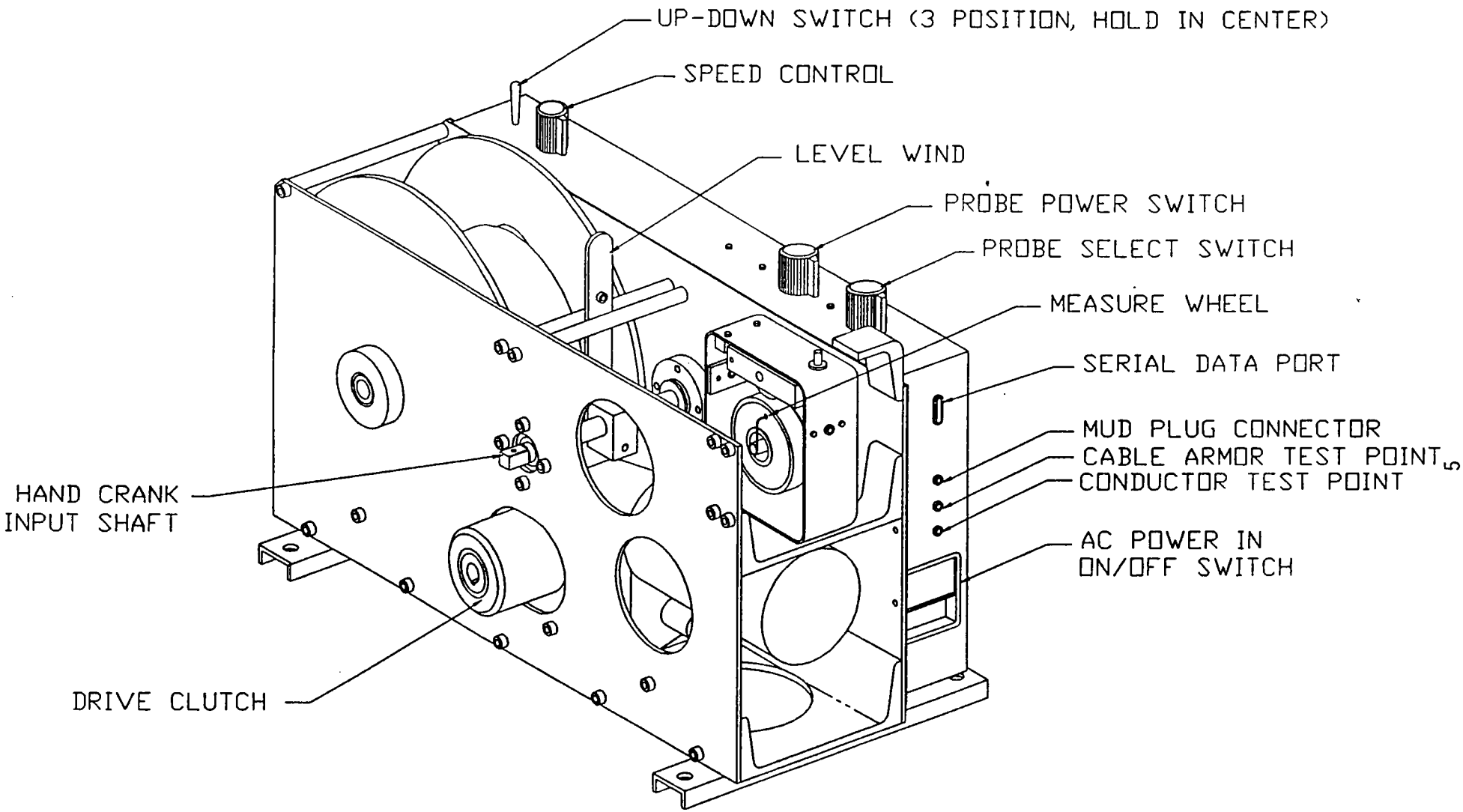

UP-DOWN SWITCH (3 POSITION, HOLD IN CENTER)
SPEED CONTROL
LEVEL WIND
PROBE POWER SWITCH
PROBE SELECT SWITCH
MEASURE WHEEL
SERIAL DATA PORT
MUD PLUG CONNECTOR
CABLE ARMOR TEST POINT
CONDUCTOR TEST POINT
AC POWER IN
ON/OFF SWITCH
HAND CRANK
INPUT SHAFT
DRIVE CLUTCH

FIGURE A

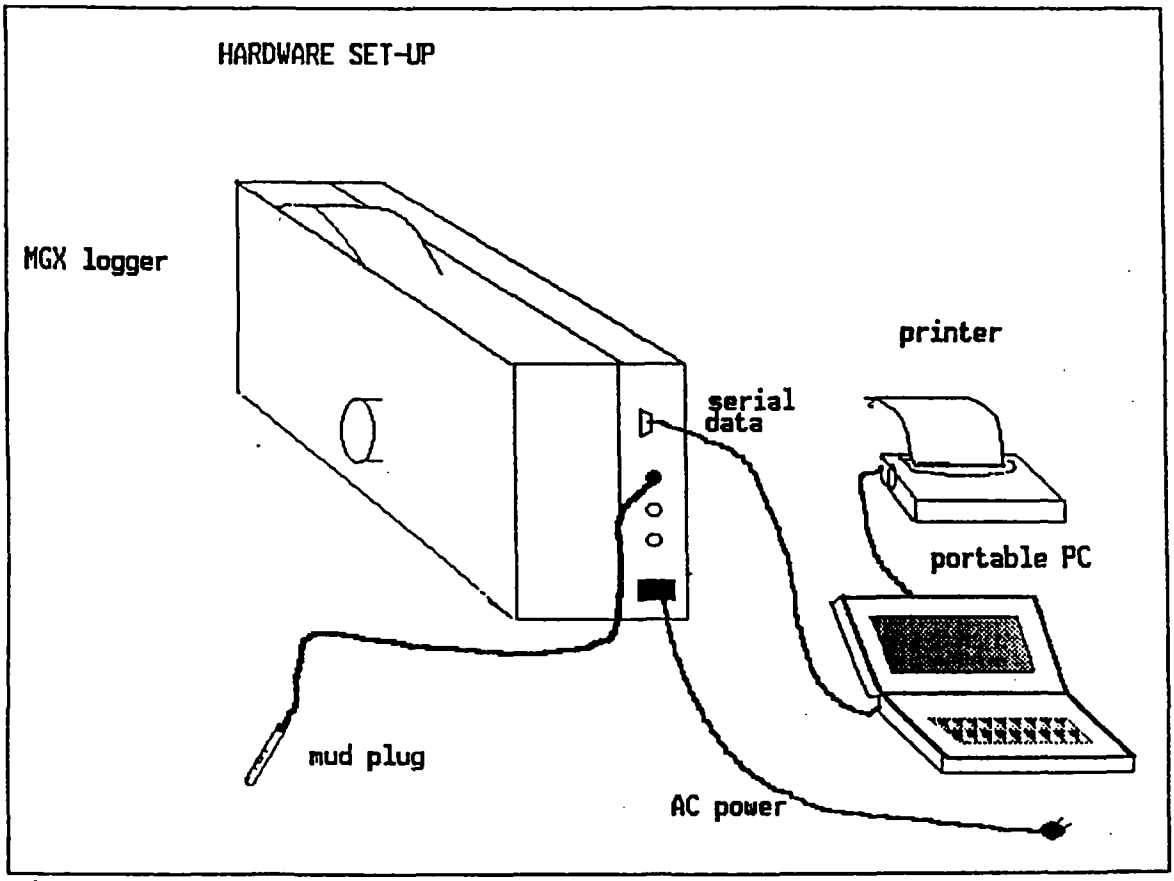

HARDWARE SET-UP
MGX logger
printer
serial
data
portable PC
mud plug
AC power

Figure B

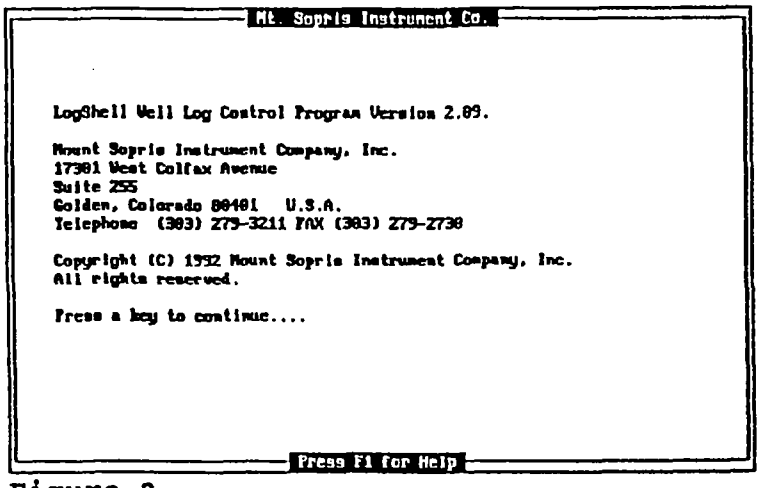


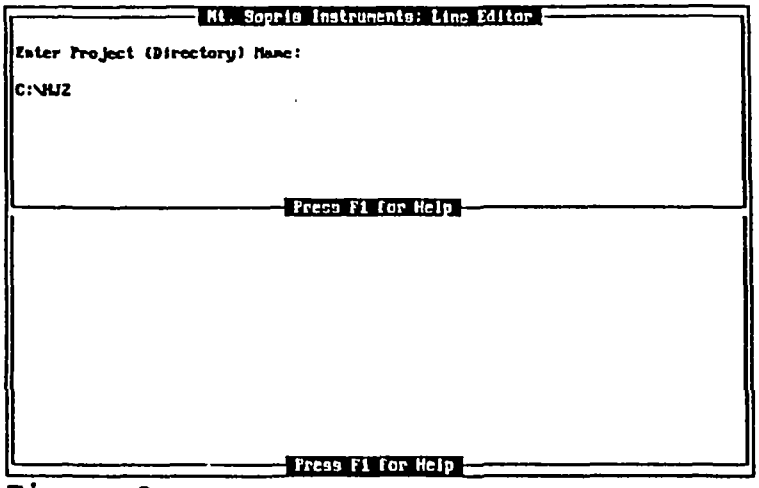
Figure 2

The LOGSHELL program is accessed by typing "LOGSHELL <ENTER>.

You should see the menu screen shown in figure 1. It lists the current version of the program. Hit any key to advance to the next screen.

The next screen will ask you to enter a project or directory name. This is where the data you log will be stored, and the plot processing information for that data is stored. You must type an entry in the space provided. It can be a new project name or an existing name. It allows you to keep all information

for a given well, project, or study in the same data directory. See figure 2. Once the project or directory name is selected, the main LOGSHELL menu will appear.



Enter the Project (or subdirectory) next.

Figure 3

The LOGSHELL main menu screen will appear next. To move around the menu, use the arrow keys to go left, right or up and down through the possible selections. To make a selection hit enter at the highlighted selection. Each selection also has a "hot-key" letter which allows the user to access that selection by simply typing that letter. For example, hit L to enter the LOG submenu. A mouse may also be used, if installed properly by the user.

LOGSHELL Main Menu

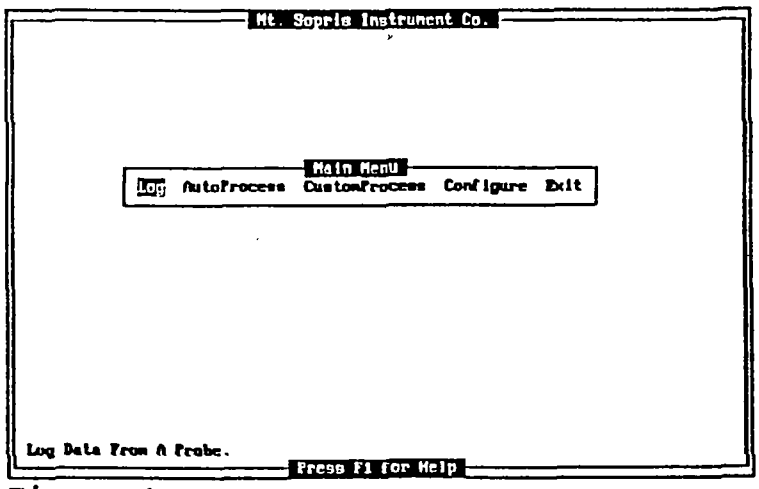


Figure 4

Before proceeding to the LOG or PROCESS selections, it is wise to CONFIGURE the system to set up your printer and probe drivers, depth system, monitor, etc. Select CONFIGURE and proceed to the CONFIGURE submenu. See figure 4.

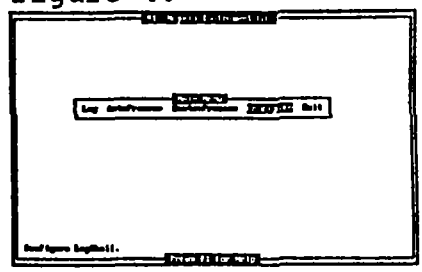


Figure 5

CONFIGURE

The CONFIGURE submenu allow the user many options. See figure 5. The first menu selection is CHANGE COLORS. It allows the user to change from a color to a monochrome monitor, and customize the colors and gray-scales available.

CONFIGURE submenu

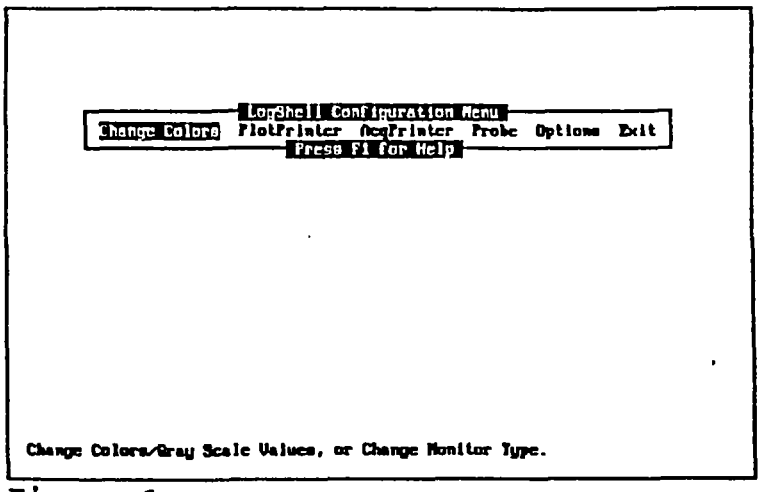


Figure 6

To change your monitor type, select the Change Monitor menu bar and you will be told what the present selection is and asked if you wish to change. Make your entry, hit enter and you will be returned to the submenu. See figures 6 and 7

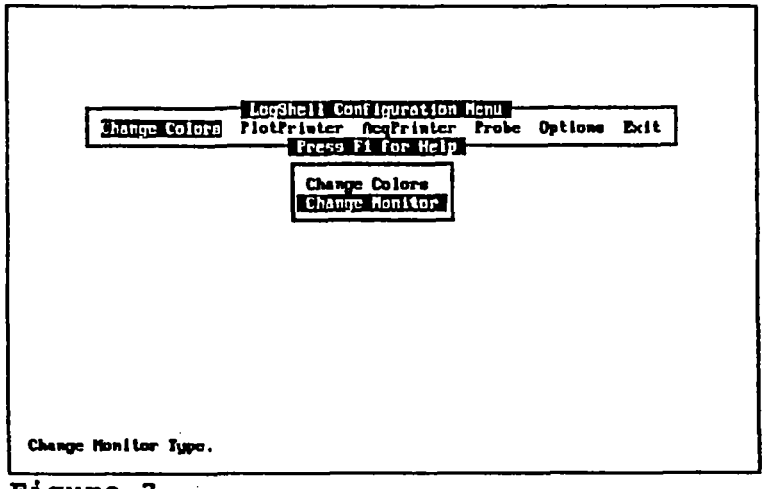


Figure 7

Change Monitor selection

Change Monitor entry screen

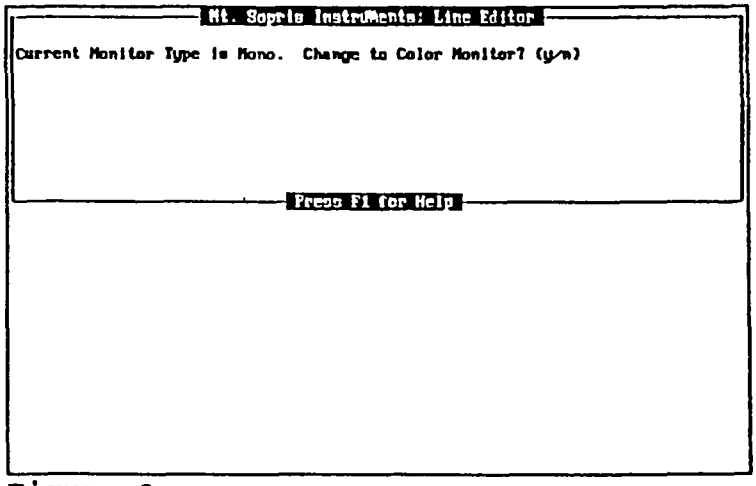


Figure 8

After selecting your monitor type, you may wish to modify the screen colors or gray scales. If your are satisfied with the screens, no entry is necessary, but some users may wish to customize the display. To do so, select CHANGE COLORS.

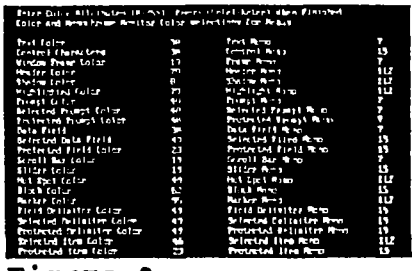


Figure 9

The color and mono menu will appear and allow the user to select any of a number of different colors for each function. To view the key that defines the colors associated with the numerical values, press **F1**, and the help screen will display all valid choices.

(see figure 9 on next page to view color palette)

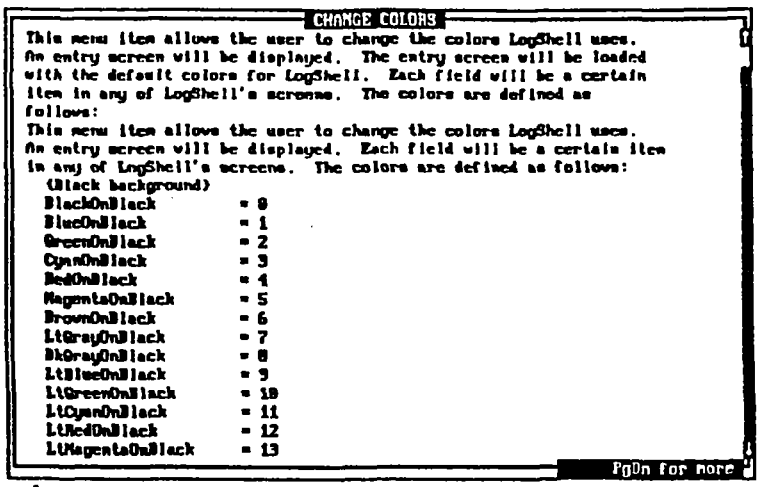


Figure 10

Color Palette for CHANGE COLORS menu

The next selections on the CONFIGURATION submenu are PLOTPRINTER and ACQPRINTER. Selecting either of these items brings up an identical set of screen choices which allow the user to 1)VIEW a currently installed printer selections, 2)INSTALL a new printer selection, and 3)REMOVE a printer selection.

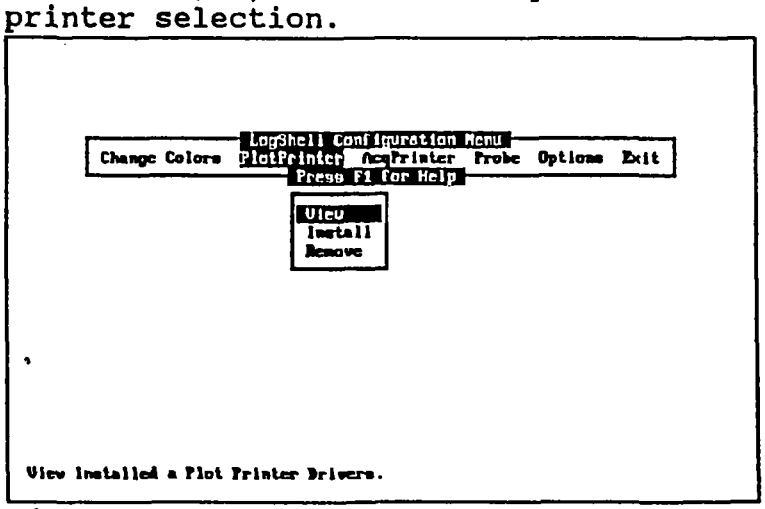


Figure 11

PLOTPRINTER selection submenu

To VIEW currently installed printer drivers that will be available in the PROCESS section of LOGSHELL, select view. Any of the displayed entries will be available for installation in the CUSTOMPROCESS portion of LOGSHELL. To INSTALL new drivers or REMOVE unwanted drivers, make the appropriate selection.

The menu selection ACQPRINTER is the same as PLOTRINTER, except that it allows the user to VIEW, INSTALL, or REMOVE printer drivers that are used during real-time plotting while logging.

The next menu item on CONFIGURE is the PROBE select function, which is similar to the two previous selections, in that it allows the user to VIEW, INSTALL or REMOVE probe drivers, which contain specific information about the individual logging probes

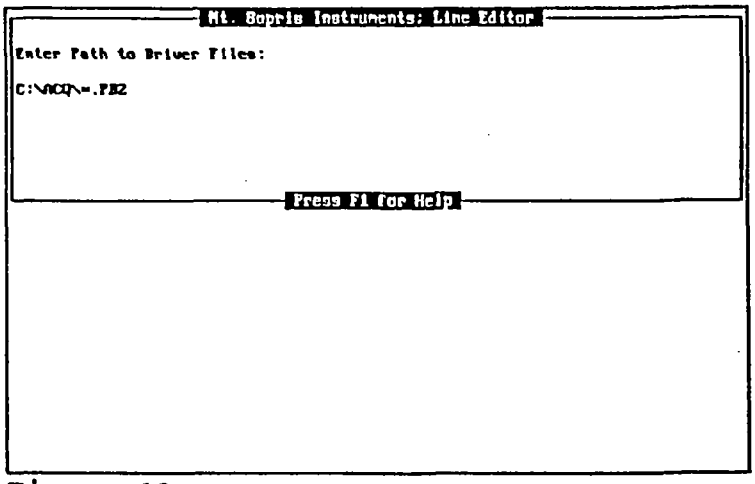


Figure 12

which can be run with the MGX logger. Such information as probe length, plotting scales, track assignment, etc., are contained in these files. It is usually only necessary to install the probe drivers for the probes you own or intend to use.

When INSTALL or REMOVE is selected, the user is shown the default directory path where the probe driver files are stored. The normal response to this menu is <enter>. The user will then be shown a list of probe drivers to install or remove, depending on the previous selection.

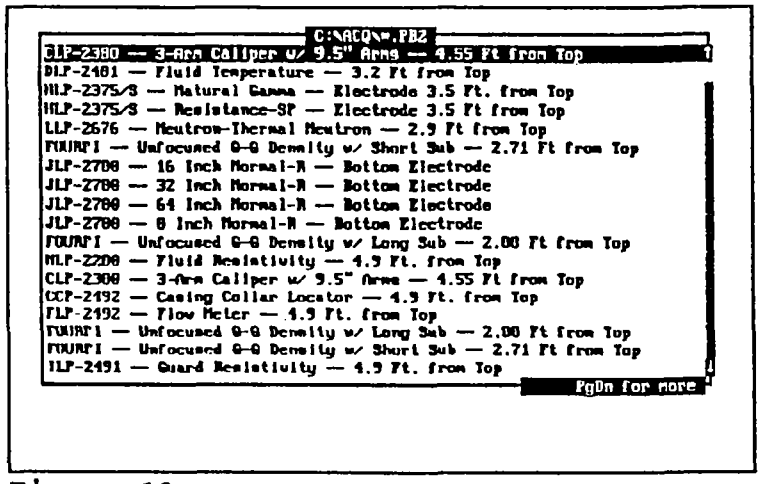


Figure 13

The user can then install or remove the desired drivers. These probe drivers will be listed in the LOG section of the program when the user is asked to enter the probe he intends to log.

The probe selection status can be checked by selecting VIEW.

THe next section of the CONFIGURE menu is the OPTIONS submenu,

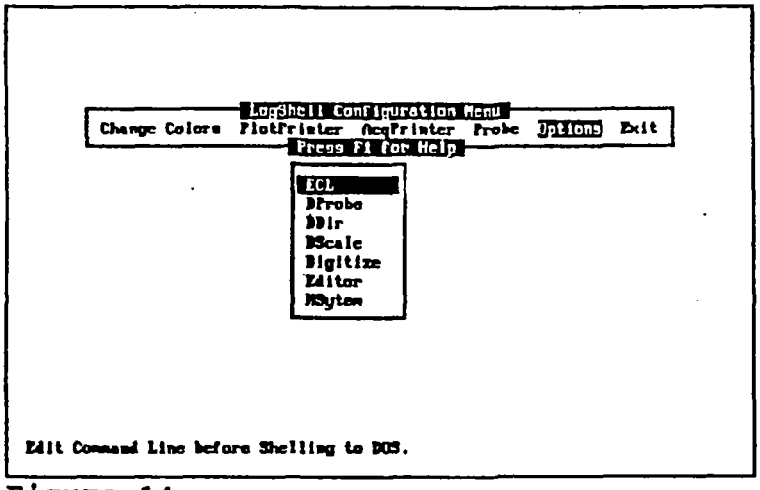


Figure 14

which allows several interesting and important choices to be made. The menu is shown below

OPTIONS submenu

The first choice on the menu, ECL, if activated, allows the user to see the command line (DOS command line) being entered during the program. It is normally left OFF.

The second choice, DRprobe, allows the user to select a default probe driver that will be installed each time the user enters the program. This option may be turned on (with a probe selection) if a user is consistently running this probe on every job and wishes to have it automatically selected when the LOG menu is entered.

The third choice is a DDIR, or default directory, which can be entered, again if the user wishes to store all log data in a specific sub-directory and have that directory automatically selected each time LOGSHELL is turned on.

THe next OPTION choice is DSCALE, which allows the user to select the depth scale in depth units per inch of log, which will be used in the LOG and PROCESS plotting functions. See figs. 14 and 15 on the next page.

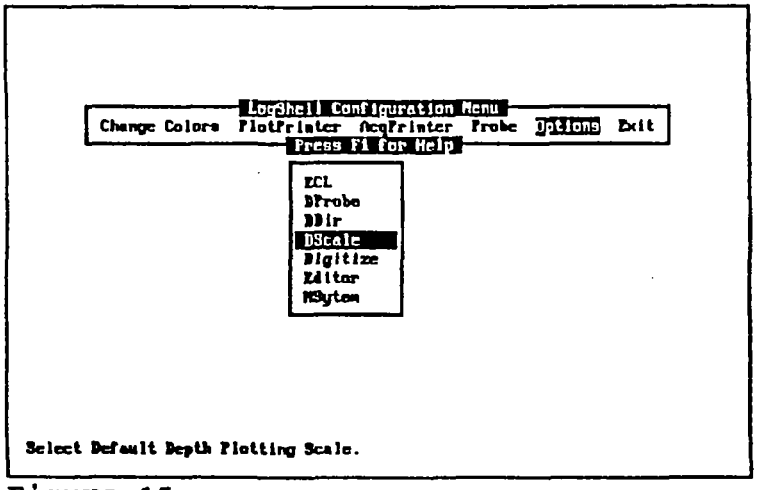


Figure 15

DSCALE selection menu

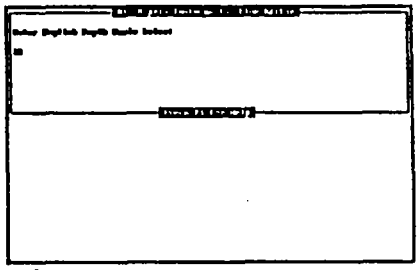


Figure 16

Enter depth scale for plotting.

The fifth menu selection under OPTIONS is the DIGITIZE interval. The user can select the intervals at which data is recorded during logging. The values entered are in feet or meters, depending on the measure system selected. Normal values are .10 feet, or .05 meter, but the user may select any reasonable value. Keep in mind that very small depth digitize entries will result in very large data files, and may require slower logging, depending on the PC. This submenu is entered just like the DSCALE menu.

The 6th menu under OPTIONS asks the user to select the text editor (EDITOR) and path to that editor. In many of the data

file menus, an editor can be called up to manipulate data in those files. At the present time, LOGSHELL comes with an editor called TPE that is invoked when VIEW/EDIT is selected. It has a help file that can be viewded when F1 is pressed while in the EDIT mode. TPE is a powerful editor and will be discussed in more detail under the EDIT portion of LOG and CUSTOMPROCESS. If desired, the user can install his own editor on the PC and re-select it with this option.

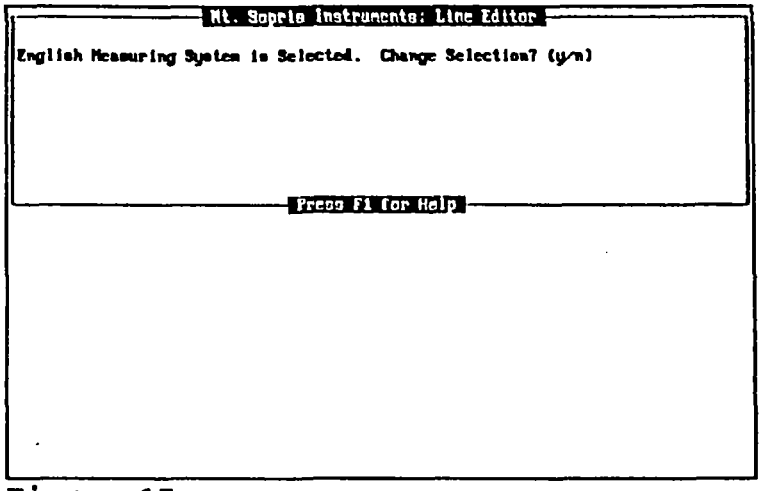


Figure 17

The final OPTION selection is MSYSTEM, which allows the user to select between the ENGLISH and METRIC systems of measurement. Make your selection in as per the menu shown in figure 16.

Once all OPTIONS are selected, you must move to the EXIT selection so that all of your new choices are saved. LOGSHELL will only let you leave the CONFIGURE menu by entering the EXIT command. It will normally not be necessary to re-enter the CONFIGURE section of the MAIN MENU. Under normal logging situations, you will probably not want to change the options you set on CONFIGURE. However, they can be changed at any time.

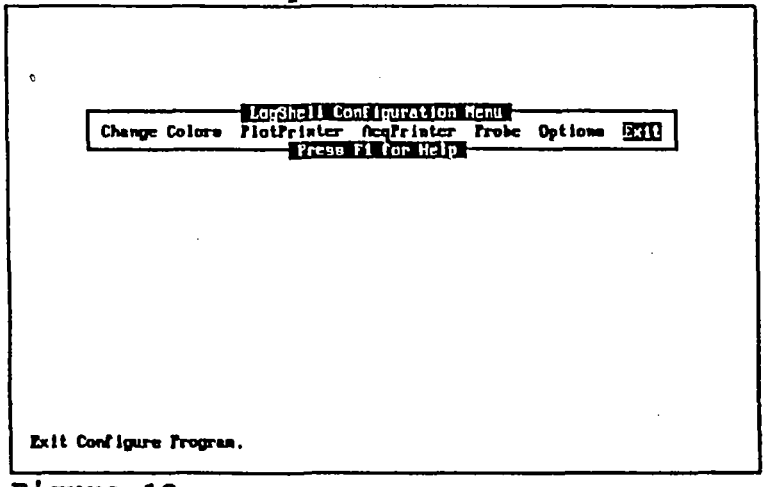


Figure 18

LOGGING OPERATIONS WITH LOGSHELL

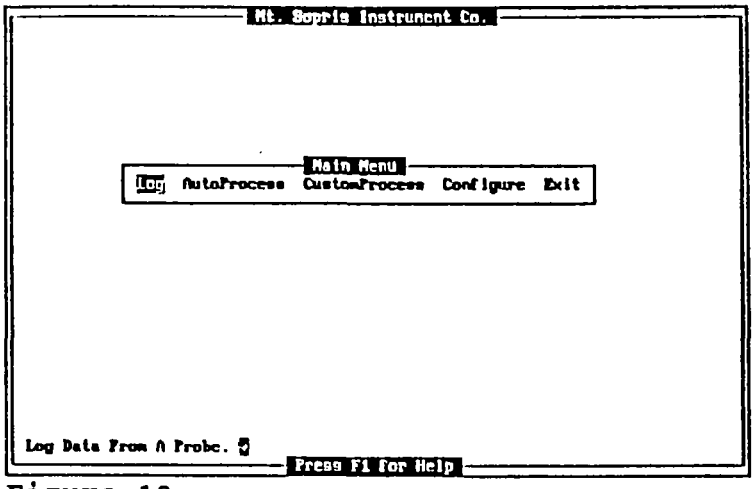


Figure 19

When you have finished configuring your system, you are ready to proceed to the logging menu. Select LOG on the main menu to enter the logging menu.

The LOGGING menu will ask the user to:

1) Select a probe
2) Name the Datafile
3) Enter starting depth
4) Select a printer
5) Begin logging

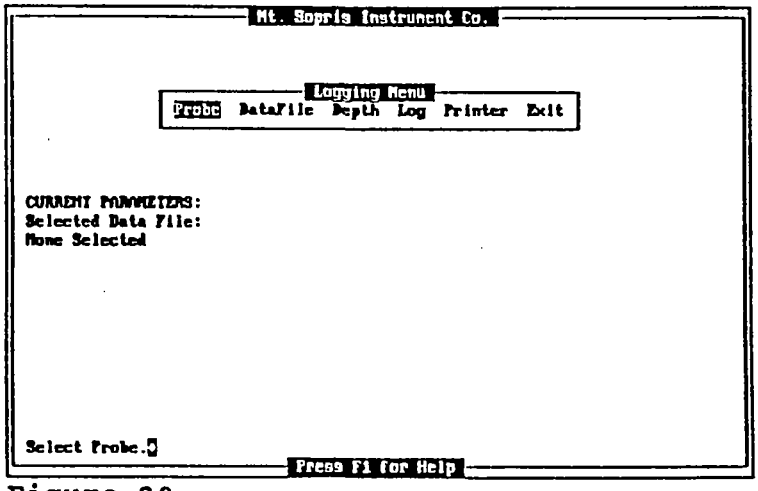


Figure 20

LOGGING MENU

Please go to next page for probe select menu.

The first selection, PROBE, will display a list of possible probes from the probe drivers that are installed in CONFIGURE.

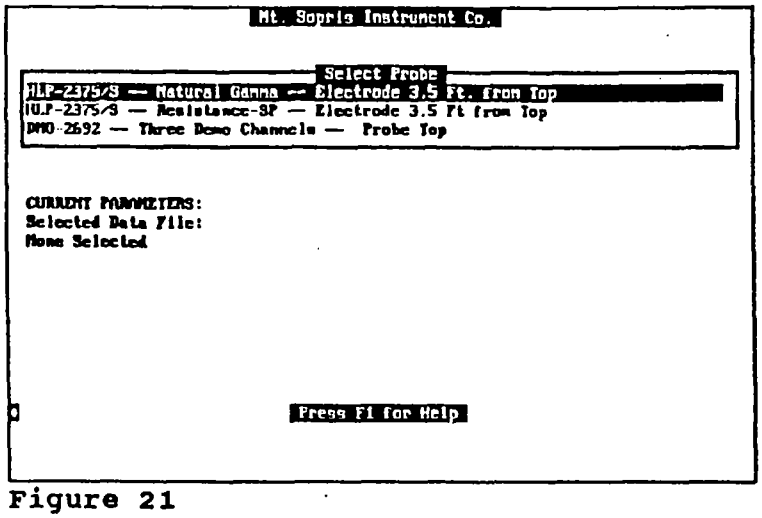


Figure 21

Probe Select Menu

The probe select menu lists the Mount Sopris Model number, the parameters measured, and the depth reference of the sensor from the probe top. **IMPORTANT: The value of the depth offset should be used when zeroing the tool to preset the sensor depth to the proper value.** See depth reference section for more information.

In the screen above, with the highlight bar on the HLP-2375/S-Natural Gamma, the user will hit enter to select this probe. The resulting screen below shows this information listed in the CURRENT PARAMETERS section.

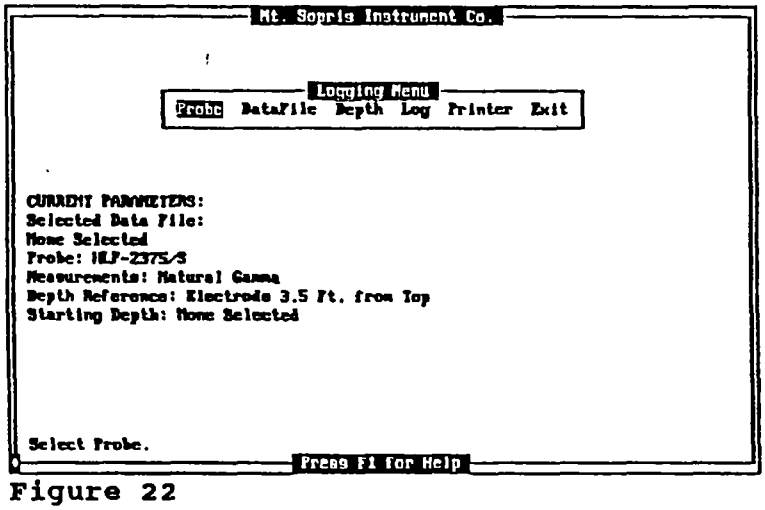


Figure 22

Probe selection is now listed under CURRENT PARAMETERS. In this case, an HLP-2375/S natural gamma probe was selected. The proper zero point for the sensor is 3.5 feet from the probe top.

In the case of the HLP-2375/S probe, the user may notice that there are two possible selections for this probe, depending on the mode selected. As the HLP-2375/S is a combination probe, which can measure natural gamma or single point resistance/SP, two selections are necessary. When the **NATURAL GAMMA** selection is made, the probe is run in the **PULSE** mode on the MGX PROBE SELECT switch. This puts approximately 30 VDC at the probe top and powers the gamma detector. Pulses proportional to natural gamma intensity are sent up the cable line. (Directions for proper switch selection are presented to the user before data can be recorded).

If the HLP-2375/S **RESISTANCE-SP** selection is made, the CURRENT PARAMETERS list will indicate this, and the user will be prompted to change the PROBE SELECT switch to **ELECTRIC.** When power is applied to the probe, a 210 Hz AC current is used to measure single point resistance and SP is measured as a DC voltage. It takes two logging runs to measure the three parameters provided by the HLP-2375/S, and the data can be easily merged and plotted on a single log with the AUTOPROCESS function which will be explained in detail in the DATA PROCESSING section.

DATA FILE SELECTION

Once a probe is selected, it is necessary to name the data file in which digital log data will be recorded. The user has already been asked to enter the project (or directory) name where the data files will reside. In the DATAFILE menu selection, the user must further specify a name for the current logging run. For example, the PROJECT NAME (DIRECTORY) may have been called XYZ PROJ, and the DATAFILE name might be BH-1. Choose a file naming convention that allows you to easily identify the data set from its name. In the above example, the file XYZ PROJ/BH-1 might mean borehole #1 on the XYZ project. It is important for the user to carefully note the names given to the data files, as the names will be needed to call up the data if additional plotting or processing will be done.

LOGSHELL automatically puts a 3 character extension on the file, so it is not necessary for the user to do so. For example, if the HLP-2375/S GAMMA selection was made, and the DATAFILE name was BH-1, LOGSHELL automatically extends the name to **BH-1.GA0.**

If several GAMMA runs were made with this probe, and you didnt't specify a name change, LOGSHELL automatically changes the extension to **.GA1, .GA2,** ... and so on. Resistance-SP logs receive a **.RA0** extension, the CLP-2380 caliper gets a **.CA0** extension, etc. LOGSHELL uses this extension convention to make it easier for the user to keep track of files.

Now, back to the LOGSHELL menu:

The DATAFILE menu contains 7 options. The SELECT option is necessary when beginning a logging run, and the user is not allowed to proceed with logging until a name is given to the data file. Figure 22 on the next page shows the DATAFILE options menu.

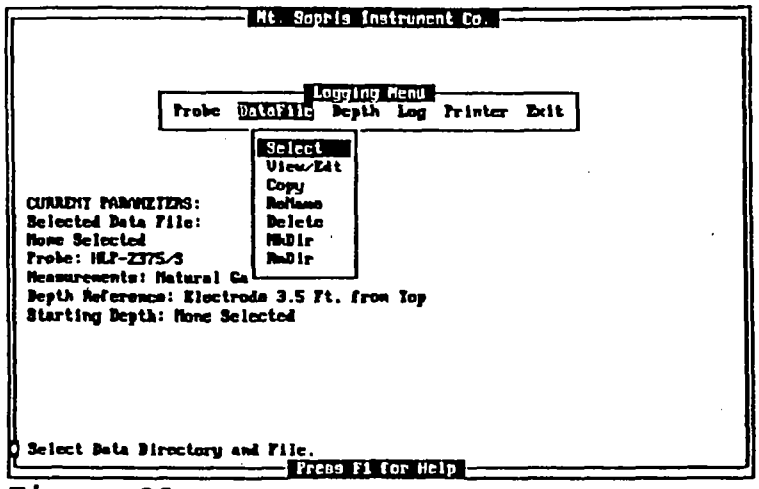


Figure 23

DATA FILE menu w/options

When SELECT is chosen by the user, the following menu appears:

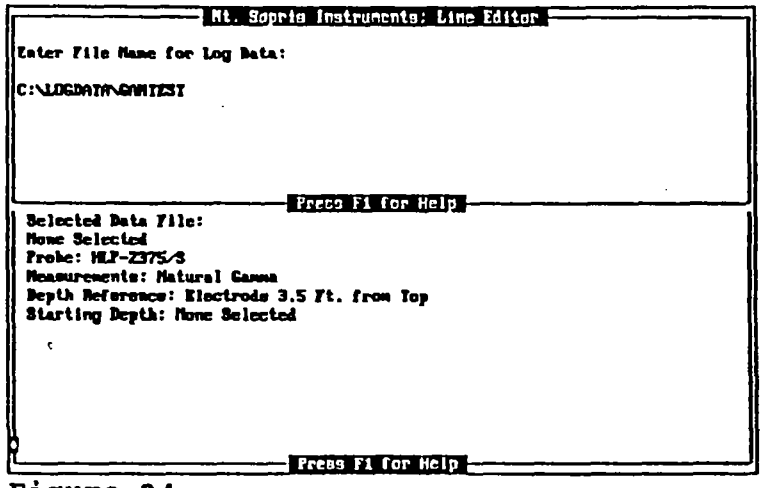


Figure 24

In this example, the project name (or directory) is LOGDATA, and the file name was chosen as GAMTEST. When the file name is entered, hit <ENTER> and the DATAFILE options menu will re-appear, this time with the data file name listed under CURRENT PARAMETERS. (Fig. 24)

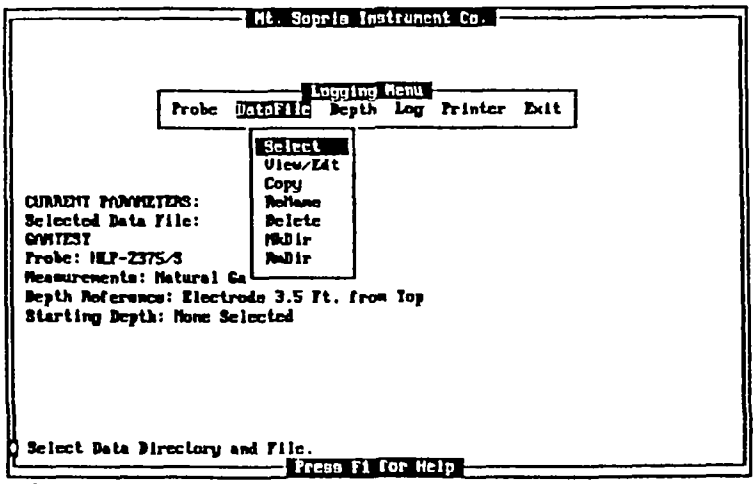


Figure 25

DATA FILE now selected

The user will notice that the DATAFILE menu offers several other selections. The VIEW/EDIT selection is normally not used in the logging menu, as no data has been written to the file. The other selections simply invoke the DOS commands COPY, RENAME, DELETE, MKDIR (make directory) and RMDIR (remove directory). This allows the use to manipulate data files without exiting the program.

ENTERING BEGINNING DEPTH

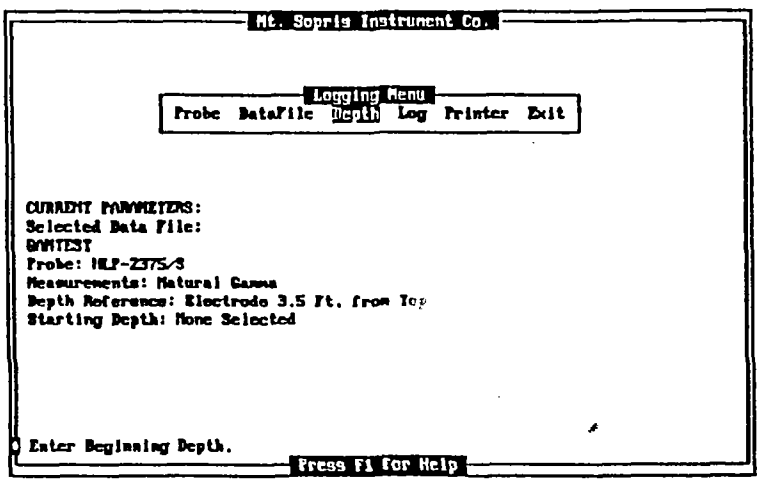


Figure 26

The user normally will proceed to the DEPTH selection of the LOGGING menu after selecting a PROBE and naming a DATA FILE.

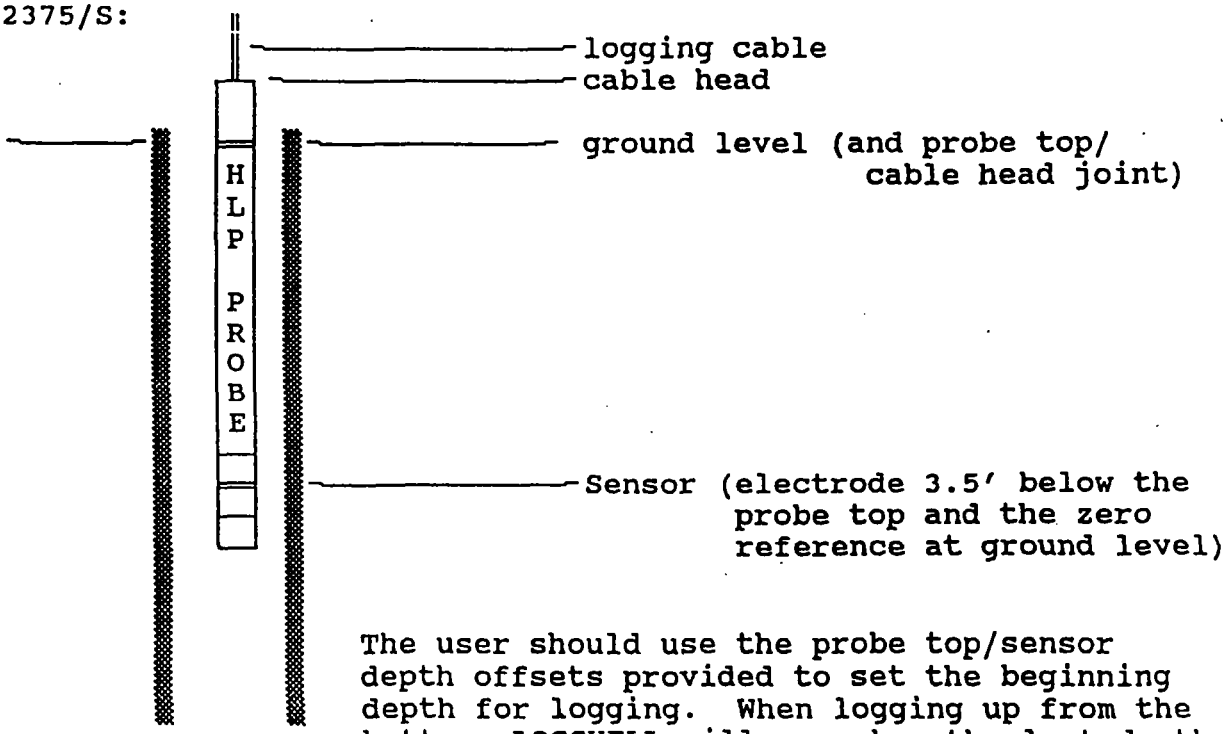
The user is then asked to enter a beginning depth. If the user is at the top of the borehole, this number is usually the depth that the sensor will be placed when beginning the log. For

example, if the HLP-2375/S Resistance-SP probe selection is made, and the user wishes to easily reference the sensor (the electrode, located 3.5 feet below the probe top/cable head joint) to the surface of the ground, he would enter 3.5 feet. The probe top/cable head join would then be positioned at surface ground level, and the log data would commence at the actual sensor position 3.5 feet in the borehole.

About Depth References:

1. It is up to the user to decide what the depth reference should be. It is normally surface ground level, but in some cases drill rig floor or kelly bushing (on a rotary rig) are used.

2. The information provided on the screen under CURRENT PARAMETERS is to assist the user in determining the value to insert in the DEPTH entry screen. The value is based on the assumption that for most logging operations, ground level will be the depth reference and the probe will be lowered into the hole such that the most obvious and easily identified point on the logging probe will be the probe top cable/head interface. All depth references are related to this connection. The drawing below shows this relationship for a typical probe, the HLP-2375/S:



The user should use the probe top/sensor depth offsets provided to set the beginning depth for logging. When logging up from the bottom, LOGSHELL will remember the last depth.

3. The MGX has NO manual depth measurement system and relies on the encoder/electronics to keep track of depth. Always remember to start the LOGGING procedure and begin LOG when going in or out

of the borehole. The depth system only operates in LOG mode. Failure to recognize this may result in losing track of where you are in the hole. It is not necessary to record data in the LOG mode, if you are running in to run a log in the UP direction. It is necessary to load the probe file, name the data file, enter the starting depth (at surface) and execute the LOG portion of the logging menu to enable the system to keep track of depth. This is **very imortant.** The logger will keep the last depth in memory when you exit from logging a specific probe, but you should not EXIT the LOG program until the probe is at the surface, to avoid pulling the probe into the sheave wheel.

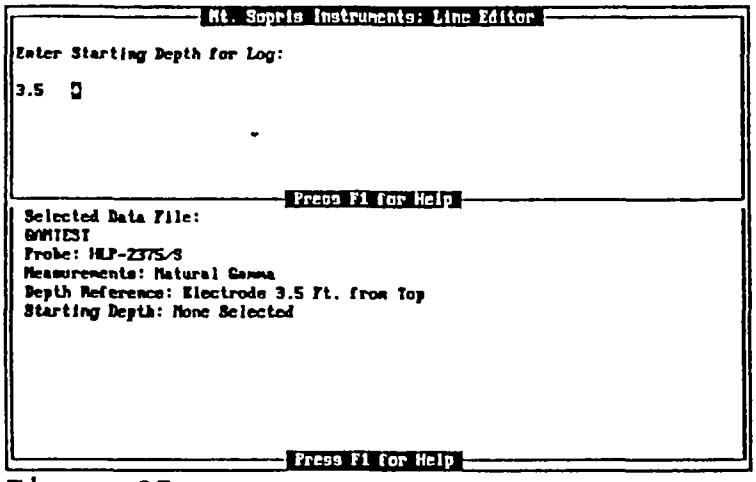


Figure 27

In this example, 3.5 is entered for the starting depth, which means that the HLP probe will be "zeroed" at the ground level surface (probe top at ground level). This means that the first data point to be recorded will be at the electrode, 3.5 feet in the borehole.

Selecting the starting depth should not be difficult if the user understands where his "zero" reference is and how far the probe sensor is from that point when beginning the logging run.

After selecting the PROBE, naming the DATA FILE, and entering the beginning DEPTH, the user may wish to verify that the correct printer driver is installed for printing the real-time log. This is only necessary if the driver has not been previously selected or the real-time printer is changed. To make the selection, the user chooses the PRINTER option and the screen in figure 27 will appear.

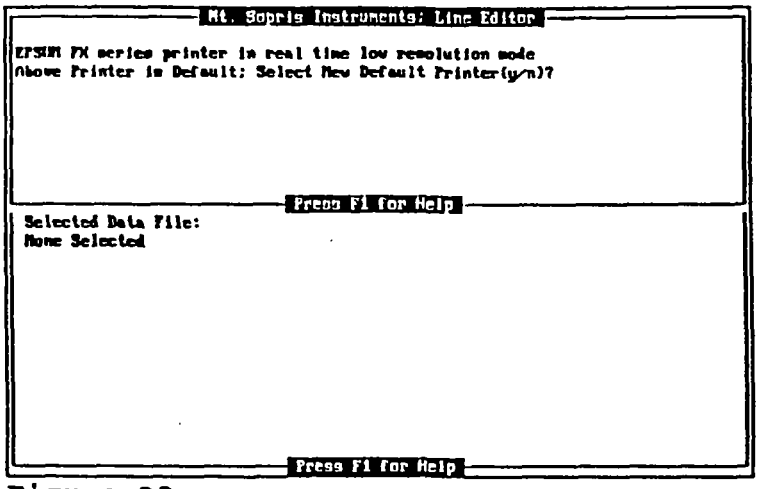


Figure 28

If the user desires to select a different printer, a "Y" should be entered here which will bring up a list of available printers from which to choose. See fig. 28.

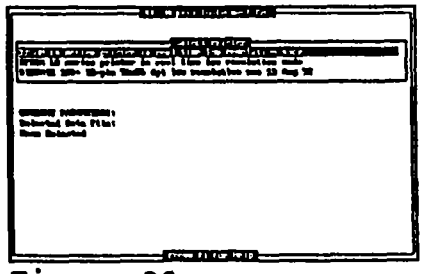


Figure 29

The user can then select a new printer by moving the highlight bar with the up/down arrow keys.

At this point, the user has now selected a PROBE, named a DATA FILE, entered the beginning DEPTH, and check to see if the proper PRINTER is installed. The next step will be the actual start up of the LOG program, which executes a program called ACQSBC. The user will be presented with a set of instructions that explain what PROBE SELECT switch position is required for the probe that was chosen. The user will be instructed to use the winch controls to move the probe (if necessary) to the beginning depth position, and power up the probe. If recording on a printer, the user should make sure the printer is loaded with paper and ON-LINE.

An example of the LOG instruction menu for the HLP-2375/S gamma probe selection is shown in fig. 30

BEGINNING THE LOG

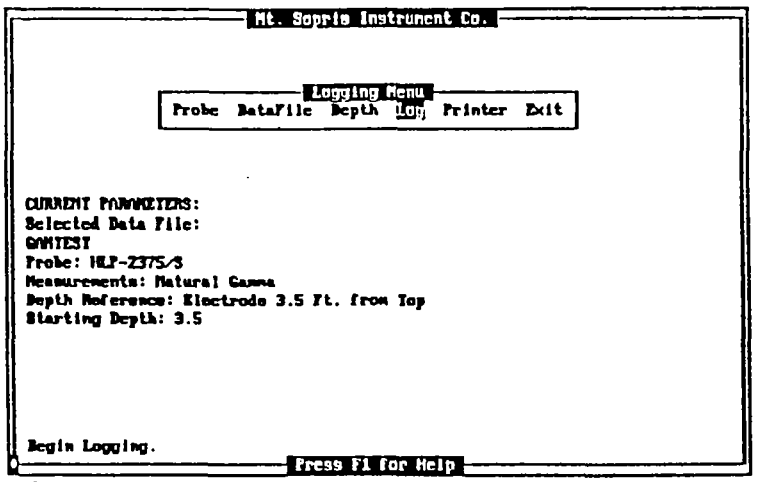


Figure 29

When all entries are made under the CURRENT PARAMETERS listing, you are ready to enter LOG.

A menu like the one below will appear, providing specific instructions for the selected probe.

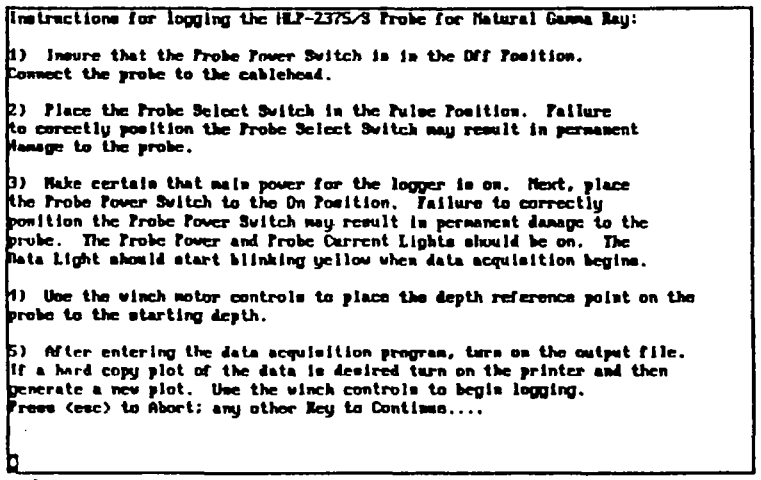


Figure 30

Follow the intructions as indicated. If the probe requires calibration, you should do so before commencing logging. Probes like calipers, and electric logs will generally require pre-log calibration. See the section on calibration for details.

The user will then be asked to hit <ENTER> to start the data acquisition program. A full screen of operating parameters will be displayed. If no printer is connected, the user will be asked to disable the printer. If a printer is installed, and is on line, then the user will be asked to enter a 10 character (minimum) well identification that will be written into the data file. See Figure 31.

```
Executing ACQSBC....

ACQSBC Well Log Acquisition (C) 1986-92 Neil W. Smith V1.18
(8/12/1992)
This copy licensed for use by Mount Sopris MGX Logging System
Customers
Serial Number 00110
Unauthorized Duplication or Distribution prohibited
Reading Default Settings from ACQSBC.DF1
Memory Available:152288 bytes.  Graphics ID code:768
Query Graphics display code:768  Using ACQUIRE.DF1 ID code:563 IBM
MGA 640x480
Bitmap is 640x480 (x1 planes) Memory after bitmap = 108528 bytes
Depth font read form DEPTH.FNT code=3080
Reading Grid definition form ACQGRID.DEF
Printer #0 Status:144 OK
Reading Printer parameters from ACQUIRE.PRP ....ii. Done
Screen:640x480 PRN:640 pixels (2.50/0.50/5.00)" @ 80x72
Ratio:1:1.000

Reading probe data from MXH2GE.PB2:
ACQSBC :MXH2GE.PB2:HLP-2375/S:Natural Gamma:RSP Electrode 3.5 ft.
from top:
10/22/92 NWS
```

Figure 31

The user should enter a 10 character identifier that will be written into the data file.

The next screen will be the ACQUIRE ACQSBC STATUS screen which displays the current settings for this logging run, which were read from the CONFIGURE information and the PROBE driver. Information such as current depth, logging speed, plotting scales, track selection for plotting, filters, trace coding, calibration data, digitization interval, etc. is presented on the screen. This screen allows the user to modify the default logging parameters if necessary, and monitor all data fields during logging.

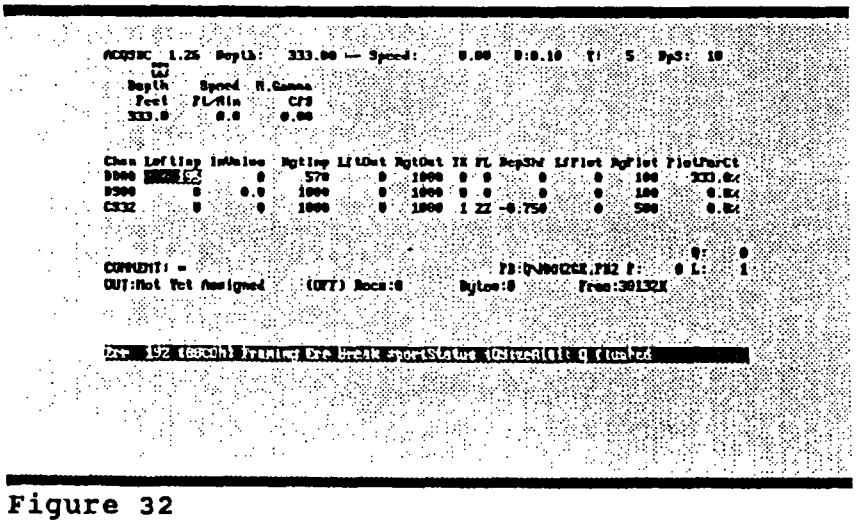


Figure 32

A **very important HELP screen** can be accessed when logging. Press F1 to view the control functions for ACQSBC. You will see the following menu:

```
Help for ACQSBC Version 1.15 Serial Number 00110 Dated 7/29/92
(C) 1986-1992 by Neil W. Smith and Mount Sopris Instrument Company,
Inc.
    17301 West Colfax, Suite 255, Golden, CO 80401 USA (303) 279-3211

F1      :Help (this screen) Alt-F1 :Fn/AltKey help on Status Screen.
F2      :Save probe configuration/changes into file C:\ACQ\MXH2GE.PB2
F3      :Calibrate LEFTInput value to current InValue. (Save using F2)
F4      :Calibrate RIGHTInput value to Current InValue.
Alt-F3 :Cal LeftInp (F3) and shift RgtInp by equal amount.
Alt-F4 :Cal RgtInp (F4) and shift LeftInp by same amount.
F5      :Switch plotting between DEPTH (DpS) and TIME (TmS) scales.
F6      :Turn recording to OUTPUT FILE GAMTEST.GA0 ON/OFF
F7      :Turn Printer (#0) ON/OFF, print Header and screen rolloff
F8      :Dump Graphics Screen to Printer, turn printer off at end of
log.
Alt-F8 :Flush printer Q (0), reset printer.  Printer must be off
(F7).
F9      :Start a New Plot (bottom to top).  Resets all plot scales.
Alt-F9 :Start a New Plot (top to bottom).  Use for logging down.
F10     :Swap between Graphics Screen and Status Screen.
```

Figure 33

When beginning a logging run, the Function keys must be used. Normally, they would be entered in the following sequence:

1. F6 Turn on data file recording to store data in user named data file.

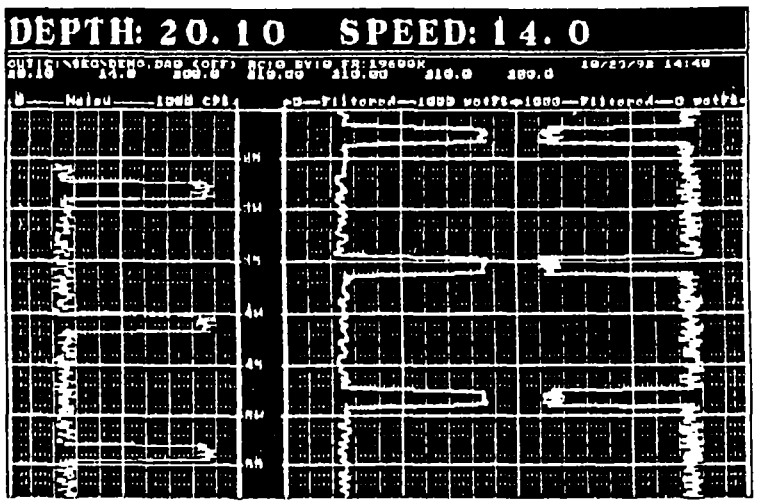
2. F7 Turn on printer (if installed and connected).

3. F9 (or Alt-F9) Start new plot up (or down).

4. When finished with a logging run, Alt-X to eXit.

Each logging run (and data file) should contain only one set of data. For repeat runs, it will be necessary to eXit the program (Alt-X). Then you may run a second log of the same type (or a repeat) by entering LOG again. LOGSHELL will auomatically assign another extension to the data file name you chose. For example, if you chose BH-1 for the first gamma log, it would be assigned the name BH-1.GA0. For a second run with the same probe, LOGSHELL would modify the extension to bh-1.GA1, and write the data into the new data file.

Remember that you can "toggle" between the STATUS screen and the "*waterfall*" GRAPHICS screen by pressing **F10**. If you wish to change a plot parameter while logging, the STATUS screen has a "highlight" bar that can be positioned over such items as depth scale, track selection (left, center, right), filter, and depth scale. Enter the change and hit F9 to start a new plot.



Sample ACQUIRE "*waterfall*" display screen

(Toggle between this screen and the STATUS screen by hitting F10)

The STATUS screen is set up so that the values being recorded show up in the vertical columns directly under the the first line. In our example, referring to figure 32, depth , speed, and natural gamma are being recorded. The second set of rows that starts with DD00 includes calibration values and information on the track location. The column labeled **TK** shows that the Depth (channel DD00, a program default) is in Track 0, meaning it won't be plotted on the printer or the screen (but will be recorded in the data file). The same can be said for Speed (channel DS00) which also shows a TK value of 0. Note, however that in this example, the Gamma (channel CS32) is plotted in TK 2, which is defined as in figure 34.

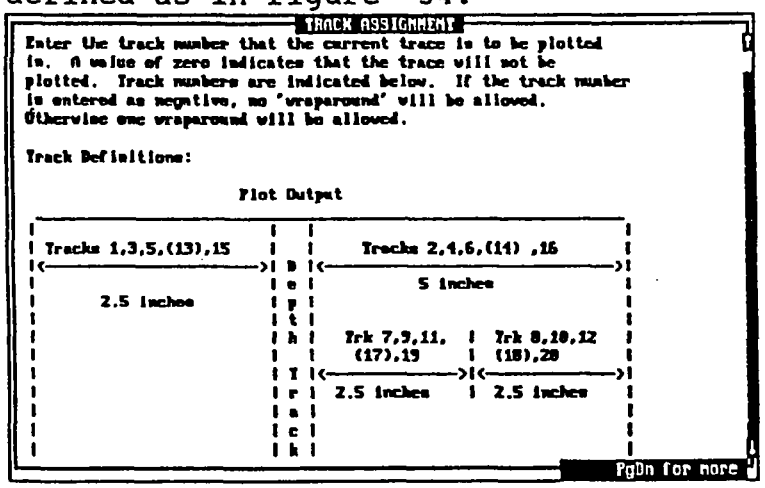


Figure 34

Note that the gamma will then be plotted in the double track on the right side of the plot, which is defined as track 2. The reason that there are so many track assignments is because traces cannot **share** tracks, so to more than one trace in a track, multiple tracks are assigned. The left hand track can have three traces, assigned to track 1, 3, and 5. This goes for the other tracks as well. Figure 34 is available on the HELP menu in the processing program when the plot parameter options are offered.

The Gamma scale is listed under the columns LfPlot (0) and RgPlot (500). The Plot % column lists the current PerCent Full scale for the data being logged. If the default scale settings are not adequate, the user can place the "highlight" bar over the appropriate menu item and enter a new value. In order for the system to finalize the desired change, a new plot must be started (type F9 for up logs or Alt-F9 for down logs.) If you wish to save your scale or track changes **permanently**, type F2 before exiting the ACQSBC program. Once again, the user is referred to the ACQUIRE HELP menu for reference, which is accessed by typing F1 when logging.

More information on the other Help Menu items can be found in the Appendix and the section on Calibration.

Once you have completed your logging run, and have eXited (Alt-X) for the last time, follow the instructions (Turn Probe Power Off).

PROCESSING LOG DATA

After you have completed logging, you will probably wish to replot some of your data on different scales, combine data from different logging runs, or make higher resolution "final prints"

LOGSHELL includes several program options which allow data processing after logging. These include:

AutoProcess-a menu option that *automatically* combines log data from multiple runs and builds a combined data file which you can view on the PC screen or print a copy. This is particularly helpful when logging the HLP-2375/S combination probe, which measures three parameters on two logging runs. You can also combine data from other logging runs, such as caliper, temperature, etc

CustomProcess-a menu option that allow the user to build custom data files up by extracting individual traces from different logs run on the same hole. CustomProcess also allows the user access to the WLCHECK statistical averaging program, the WLHEAD header plotting program, Cal2PT (a calibration program), and PRNPLOT and SCRNPLOT for printing or displaying the customized files.

The AutoProcess program features will be discussed first.

The user should <Esc> or Exit back to the main LOGSHELL menu and highlight the AutoProcess selection.

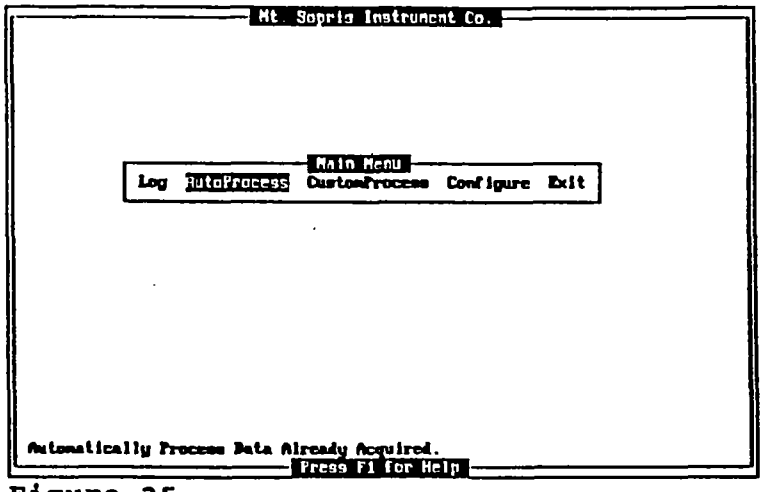


Figure 35

The user will then be asked if current Project (directory) files include the data that will be processed. The user can enter any project (directory) that includes valid data files. Once again, the user is reminded to record Project names during logging for future reference to make re-selecting files easier.

A menu similar to Figure 36 will prompt the user for this selection:

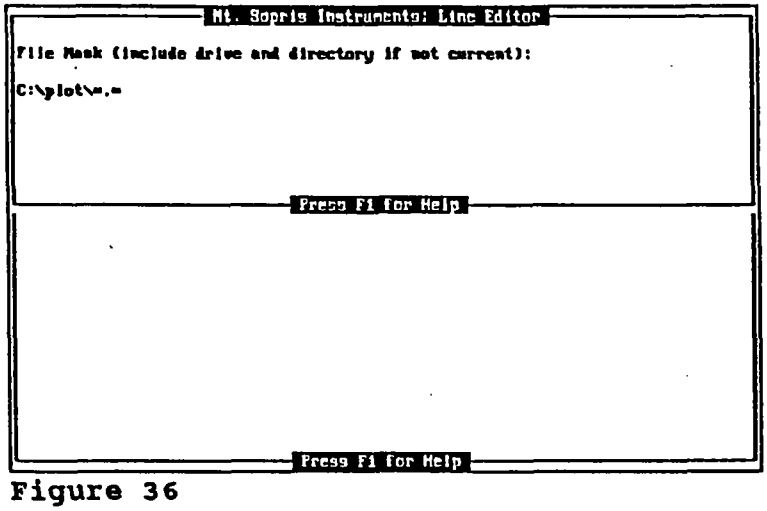


Figure 36

Once the user has selected the Project (directory), and hits the enter key, a menu showing all valid data files will appear as in figure 37.

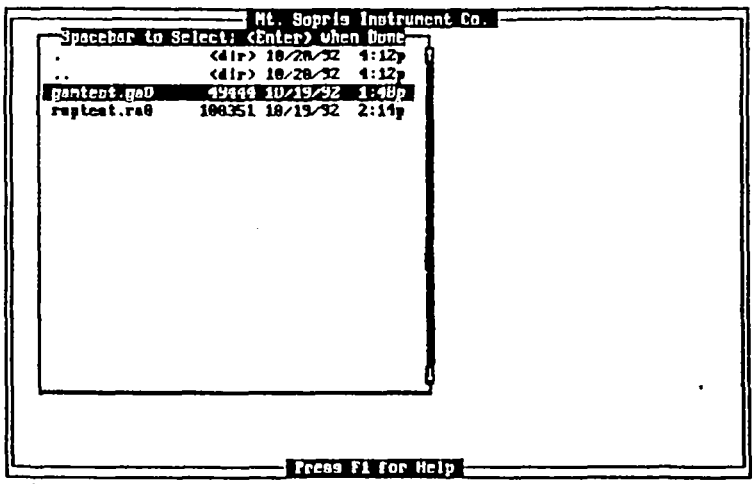


Figure 37

In this example, only two data files are present, one including gamma data and the other including R/SP data from the same well.

The user must select the files that are to be automatically merged together. To select files, the highlight bar is positioned over the desired file, and then the **Space Bar** is used to select the file (not the enter key).

When a file is selected, it will have ! exclamation ! marks surrounding it. To "un-select a file, simply toggle the space bar to remove the !___!.

In the example below, (figure 38) we have selected both data files, indicated by the !____! marks.

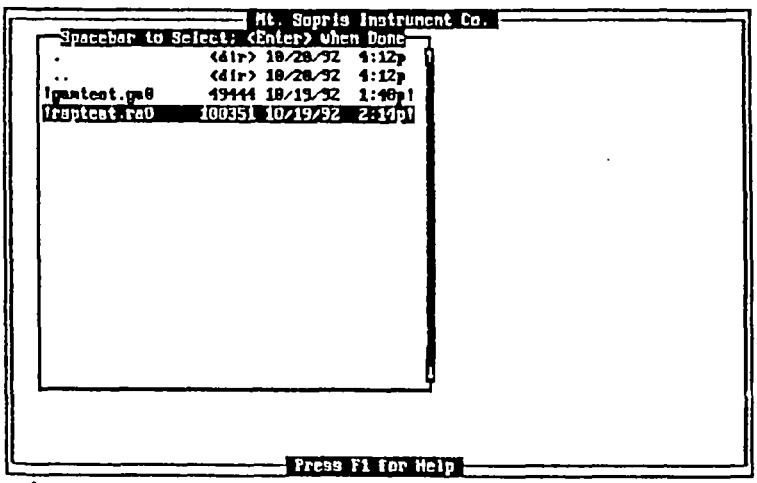


Figure 38

Both files have been selected. To run AutoProcess, Hit <Enter>.

When the <Enter> key is pressed, LOGSHELL calls up a series of programs that do the following:

Interp — Interpolates the data file to match the depth intervals from the selected data files, filters data if needed or desired. (more about this in the APPENDIX).

Invert — Inverts the files where data was logged DOWN, so that all data files are tabulated in the same direction. Depths are generally listed in decreasing values.

Hmerge — Horizontally merges the Interped and Inverted data

The user will be asked to hit <any key> to continue or <esc> to abort. If the data files are valid, the user will normally respond with <any key> to keep the program going until the next menu appears. When the data files have been successfully combined, the user is asked if the data should be directed to a printer or the PC display screen. See figure 39.

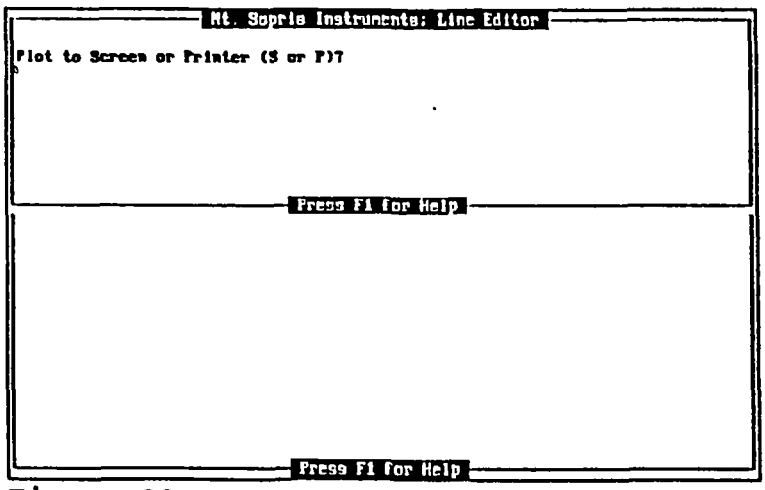


Figure 39

If the user is sure that the scales in the original logging runs were satisfactory, the new data file can be directed to the printer.

If the user would like to preview the new data file on the screen, then S should be selected.

NOTE: Some PC keyboards will require the <Enter> and <PgUp>, <PgDn> keys to be pressed TWICE to execute the SCRNPLOT functions.

An example of the data file that might be diplayed on the PC screen is shown below:

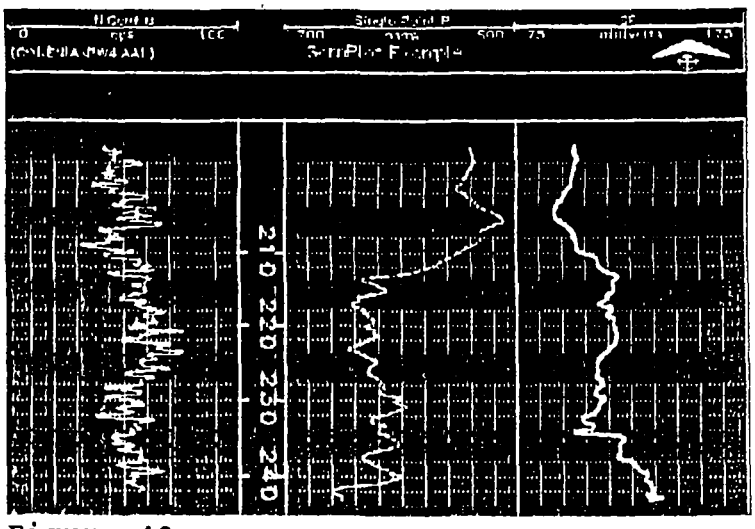


Figure 40

Screen display of AutoProcessed data

If the user is satisfied with the AutoProcess display on the screen, the <esc> key can be pressed, and the user is presented with 3 choices:

P change plot parameters

R re-plot same plot to screen or printer

E end processing and return to Main Menu

Select R and then plot to Printer (P) if a hard copy plot of this data is desired.

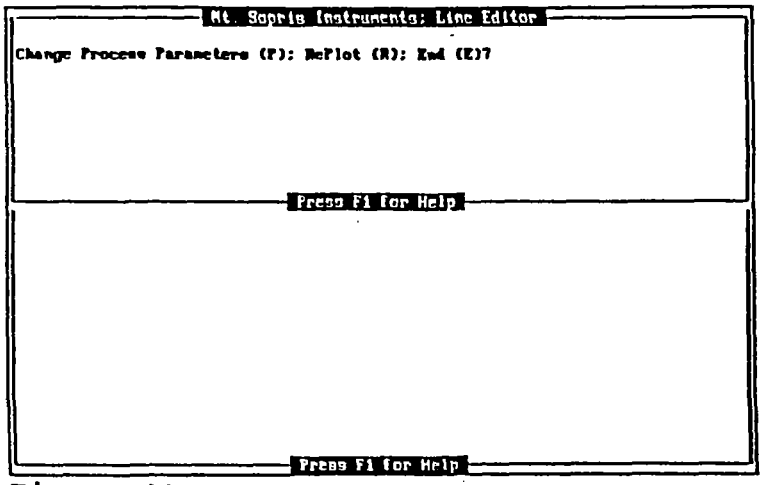


Figure 41

The selection menu

If the user wishes to plot the log without making changes, then enter R (for re-plot) and then P to direct the plot to the printer.

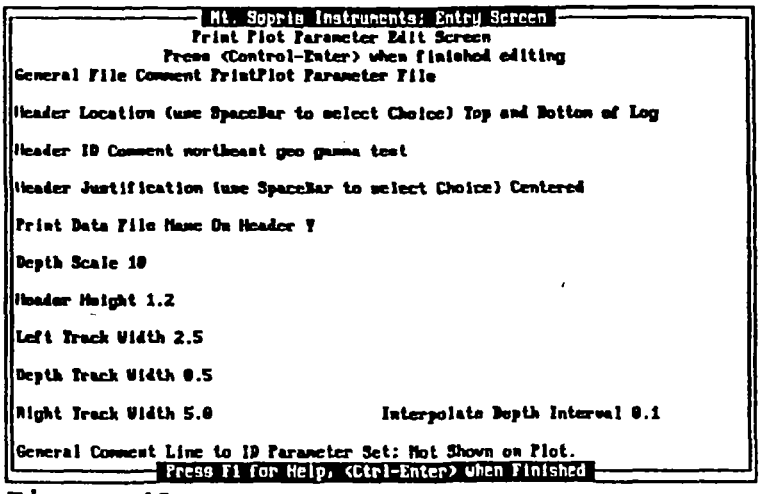


Figure 42

However, if the user wishes to modify the plot output, change scales, dash a trace, edit titles, etc. then P should be selected. The user is then presented with the PRNPLOT plot editing menus, which contain general information on the plot, and specific information on each trace to be plotted.

Figure 42 shows the edit screen for the general plot .

Once again, if a user has questions about what each menu item describes and how to change selections, hit F1 at any entry point to get HELP for that item.

Use the TAB key to move through menu items.

The LOGSHELL program will only accept valid data for each entry, and the user should consult HELP if in doubt about a selection.

Once the general plot screen is edited, the user will advance automatically to the first plot trace edit screen. Each plot trace will have a full menu screen, and the user can move between screens by hitting PgUp and PgDn. Figure 43 shows an example plot trace edit screen.

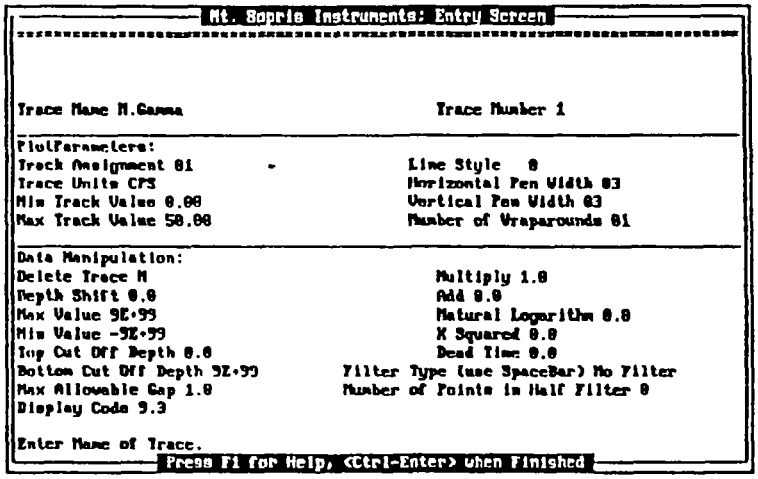


Figure 43

The plot trace Edit Screens allow the user to change scales, change trace coding from solid to dashed, etc. and allow filters to be applied. Many mathematical functions can also be applied, as well as depth shifts.

The user is urged to use the HELP menu to assist in modifying the Edit screens. At each step in the process, HELP provides simple instructions on how to enter the changes.

Once all EDIT changes are completed, the user **MUST HIT** **<Ctrl><Enter>** to SAVE the changes. If this is not done, and the user exits by hitting <esc>, the changes will be lost and the plot will **not** be modified.

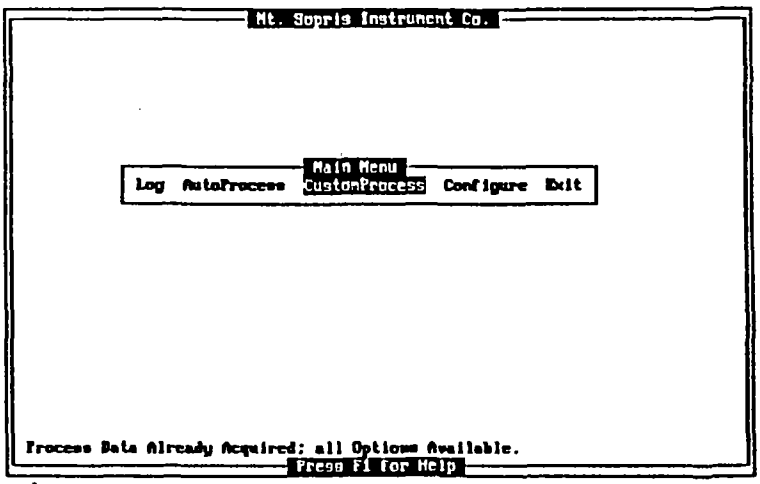


Figure 44

To enter the CustomProcess menu, go back to the main menu and make the selection as in Figure 44.

CutomProcess give the user access to the full power of the PRNPLOT, WLCHECK, INTERP, WLHEAD, and Cal2Pt programs, and allows for much more flexibility in editing and presenting log data.

As in other sections of LOGSHELL, CustomProcess guides the user through the menus, and won't allow the user to proceed until all necessary selections are made. The Custom Process submenu contains several options with their own submenus. See Figure 45.

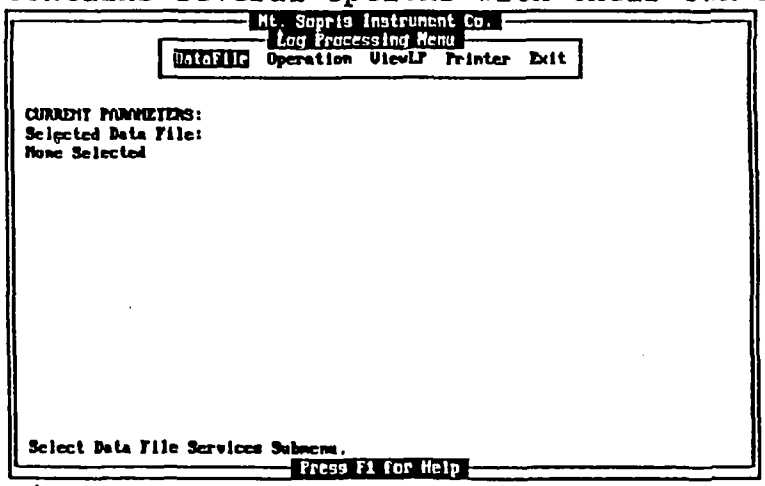
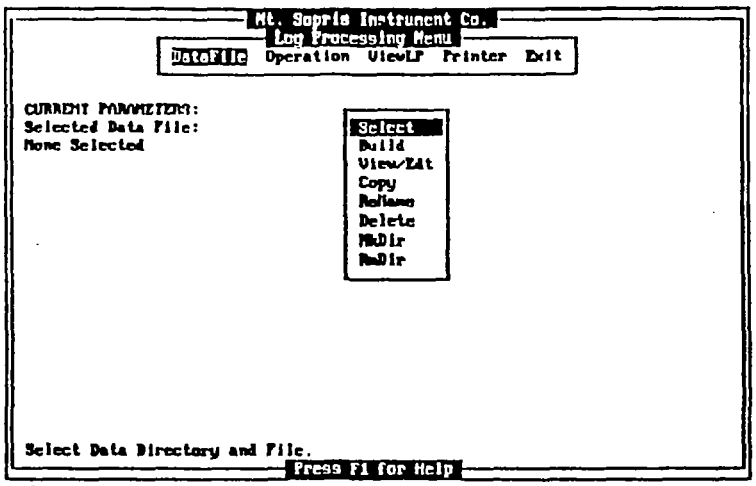


Figure 45

In general, to use CustomProcess, you must be sure your current printer is selected (as explained in the CONFIGURE and

The submenu a right indicates that the DATA FILE services option is selected.

The user can SELECT a data file to view or edit. This file may also be plotted, etc., in the OPERATIONS submenu. The DATA FILE services submenu also allows the user to enter the BUILD option which is a powerful tool for constructing composite data files from individual log runs.



The Select File menu

Figure 46

The Select File Mask and data file name screen appears, as in Figure 47.

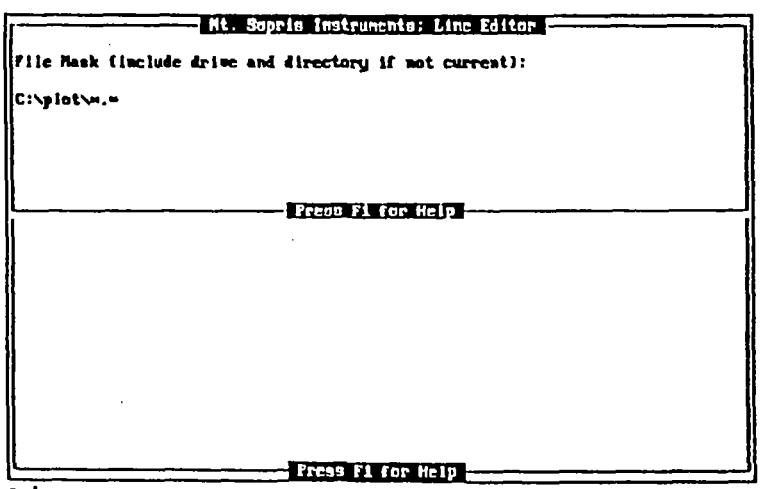


Figure 47

After selecting the file mask (project or subdirectory), the user is presented with a list of valid files such as those shown in figure 48 below:

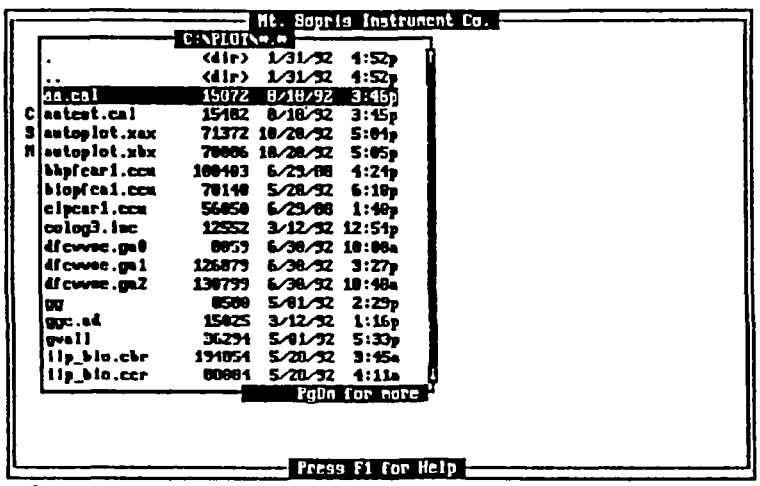


Figure 48

Listing of valid files

Highlight Bar is on the file AA1.CAL

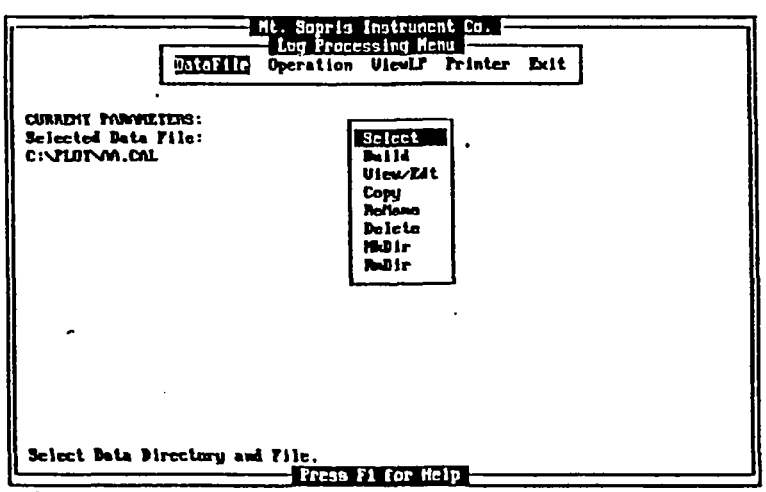


Figure 49

CURRENT PARAMETERS indicates that AA1.CAL has been selected.

The DATA FILE services menu allows the user to VIEW/EDIT the selected data file, COPY it to another directory, RENAME the file or DELETE the file. The user can also MkDir (Make a new Directory) or RmDir (Remove an old, empty directory) from this menu, without having to exit to DOS.

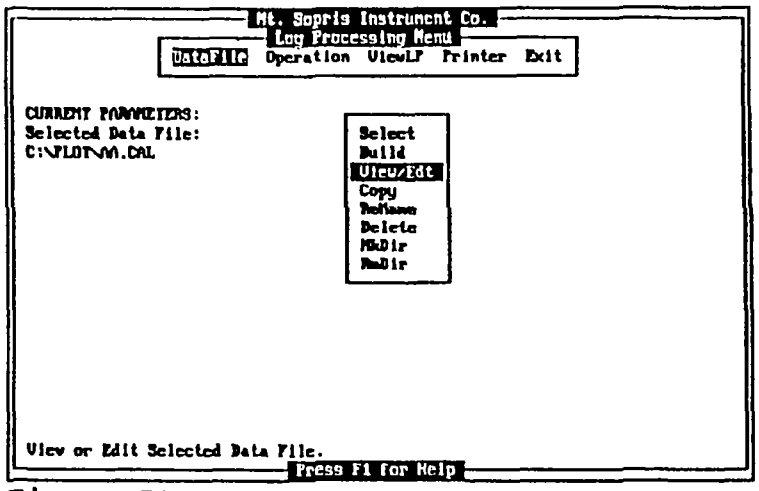


Figure 50

VIEW/EDIT selected. The data file will be loaded into the TEXT EDITOR. Present versions of LOGSHELL are delivered with the TPE text editor. The LOGSHELL data files are written in ASCII text format, and the user can install a preferred editor in CONFIGURE, if desired.

The TPE text editor displays the data file in the format as shown in figure 51. The file contains several lines of "header" information and then rows of depth, speed, and data fields separated by spaces. The edit commands for TPE can be accessed by typing F1 when in the VIEW/Edit function. To SAVE a file and EXIT, type ALT-X

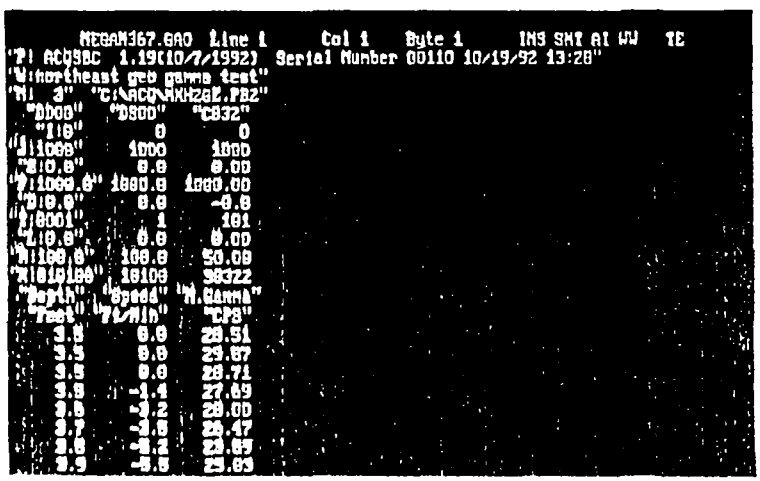


Figure 51

AA1.CAL as loaded into the TPE editor (VIEW/EDIT submenu)

The last selection in the DATA FILE SERVICES submenu is BUILD. This powerful tool allows the user to select individual traces from different files (same wellbore) and combine them in a new data file. The process involves 1) naming the new file, 2) selecting the Files/Traces, and 3) Merging the traces.

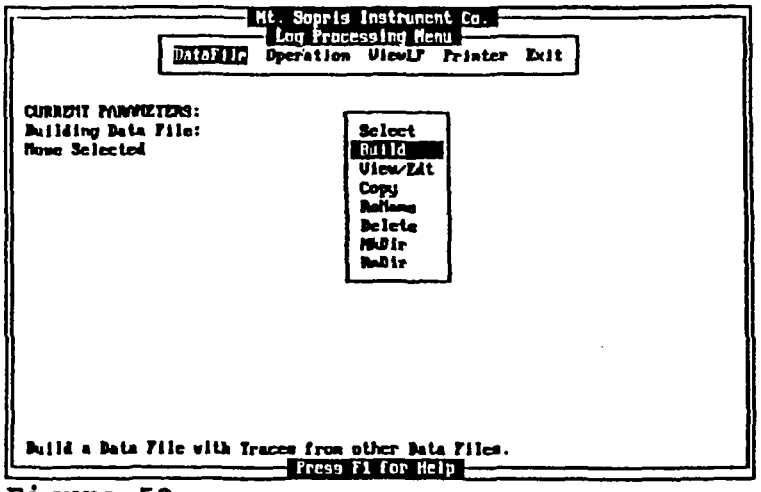


Figure 52

BUILD menu selection

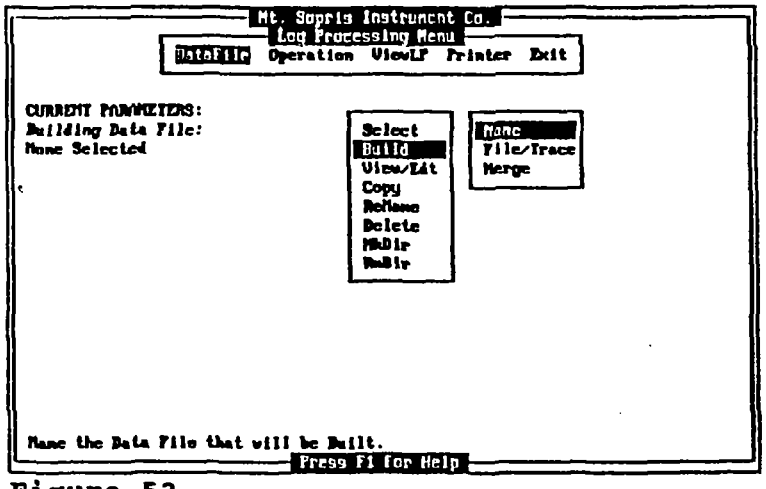
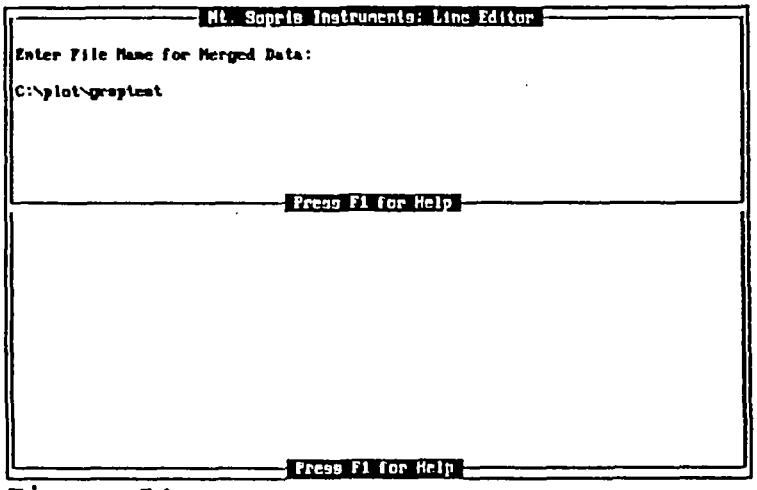


Figure 53

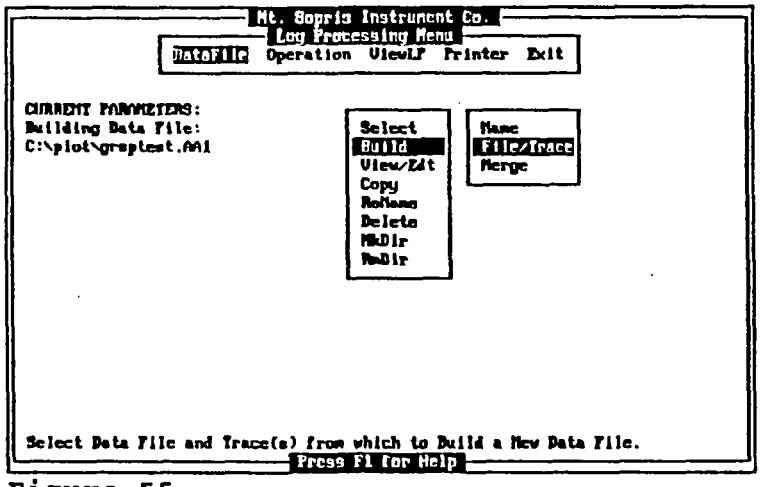
Build Menu choices (Name, Files/Traces, and Merge)



The NAME of the new file is entered, which for this is example, is GRSPTEST.

Figure 54

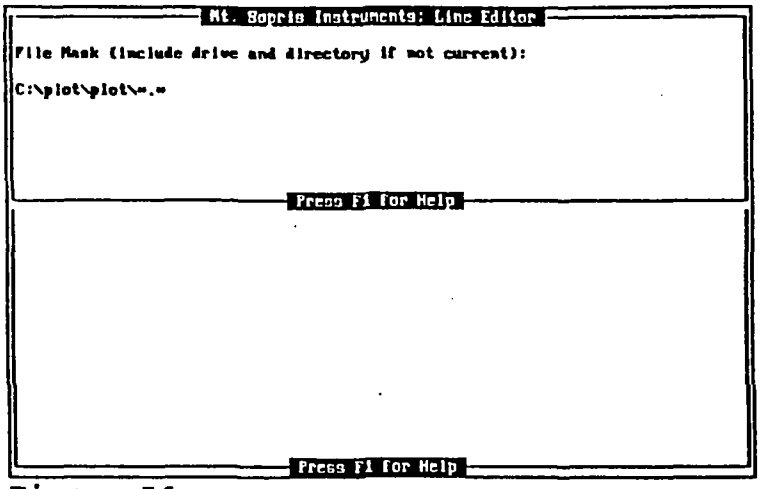
The next selection prompts the user to select the FILEs and TRACEs from which to build the new file. Figure 55 shows this menu item selected.



FILE/TRACE selection menu

Figure 55

The user must specify a PROJECT directory (or file mask) before selecting the files and traces that will be merged
The menu in Figure 56 asks the user to enter the directory or Project Name that contains the files desired.

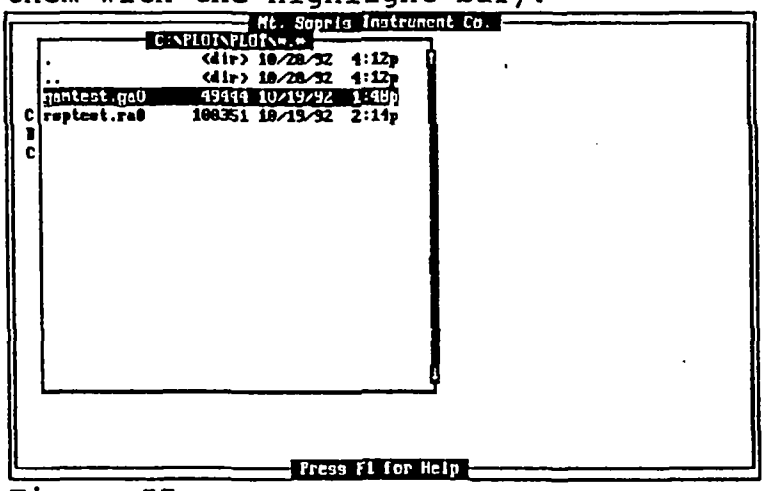


Enter Project directory or file mask

Figure 56

After entering the Project directory, the user is then provided a list of files to select.

When a file is highlighted and the enter key pressed, the user will then use the arrow keys to locate the traces (and highlight them with the highlight bar).



File list for BUILD

Figure 57

To select a trace, press the <SPACE BAR> as was done in AUTOPROCESS file selection. This will surround the file with exclamation points (!trace.name!) to show it is selected.

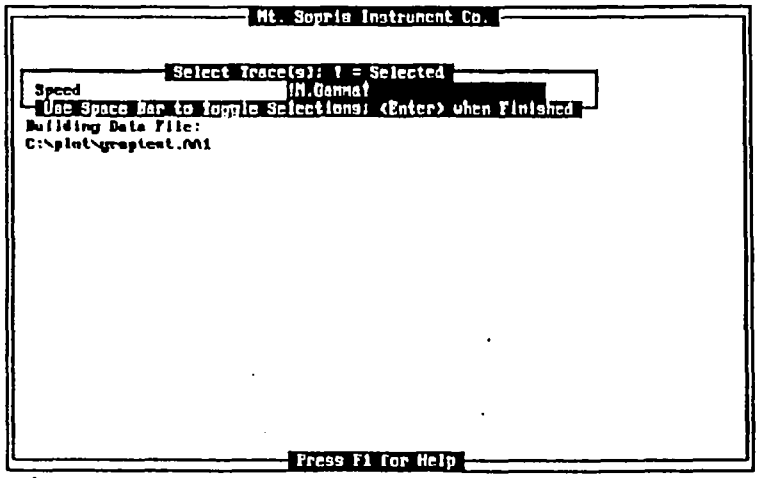


Figure 58

Trace selection Menu

Do this for each trace and file. When this is completed, the CURRENT PARAMETERS menu will list the files/traces selected and list the name of the new file.

MERGE

The final selection in the BUILD menu is the Merge command. When this menu item is selected, it causes several subprograms to execute. These programs include INTERP (to interpolate new data values so that all log data has common depth intervals and apply filters, depth shifts and mathematical operations if needed), INVERT (to reverse the order of logs recorded going DOWN), and HMERGE (to merge log and header data into a common file).

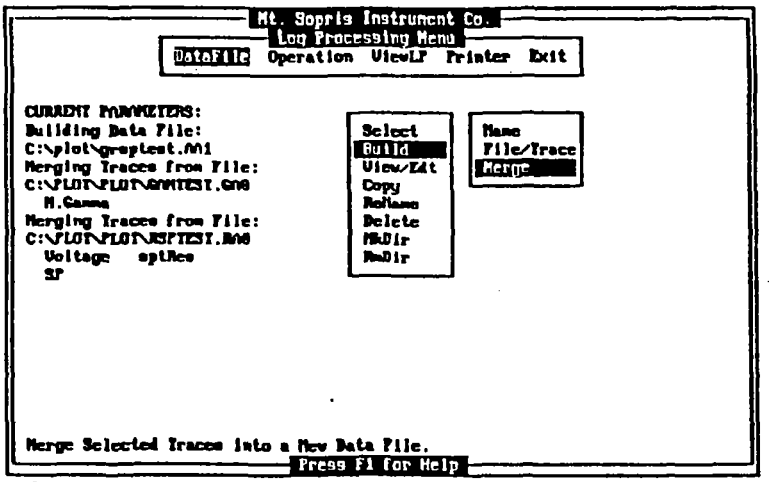


Figure 59

Note that the CURRENT PARAMETERS displays the name of the output file and the files/traces selected for the BUILD function. The user should verify that the selections are correct before executing the MERGE command.

After MERGING data from various files, the user may wish try other features of the CustomProcess menu, which can be found by moving to the OPERATION submenu. FIGURE 60 shows this selection.

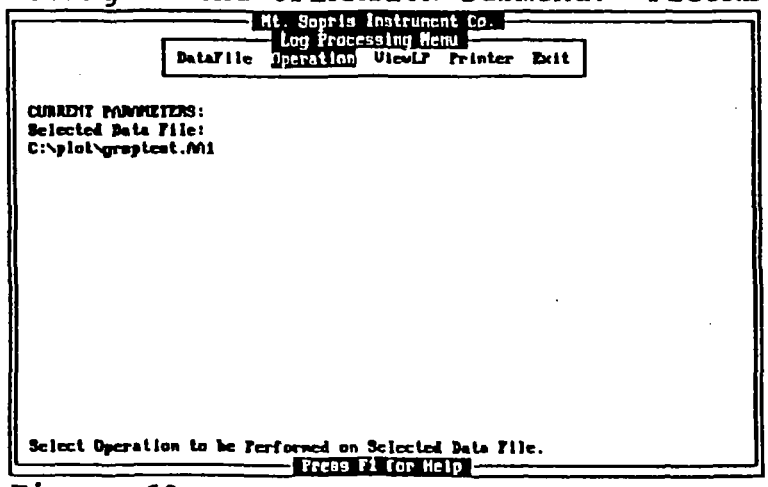


Figure 60

Note that a data file must be selected before the user is allowed to enter the OPERATION submenu.

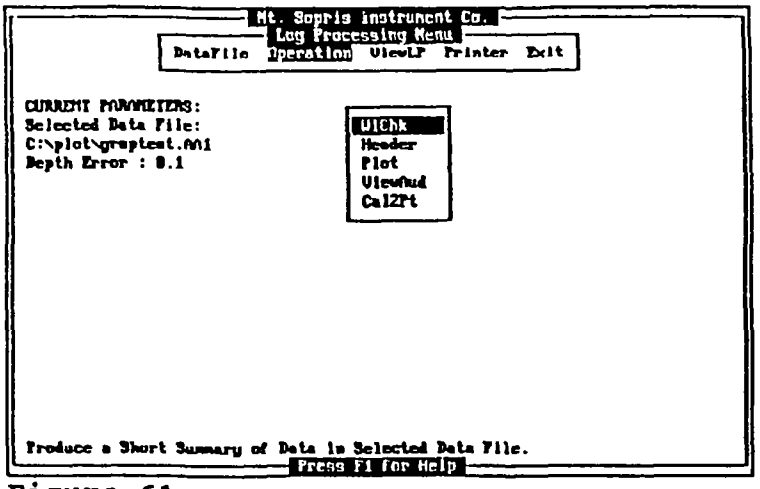


Figure 61

When OPERATION is selected, the user is presented with several options.

WLChk
Header
Plot
ViewAud
Cal2Pt

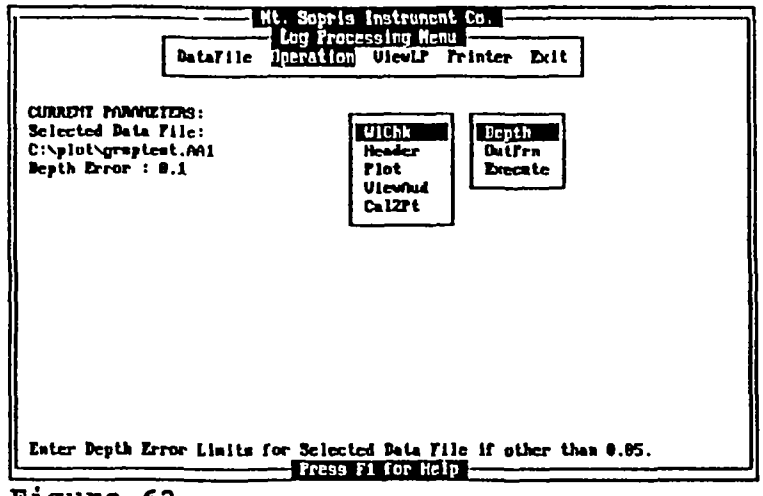
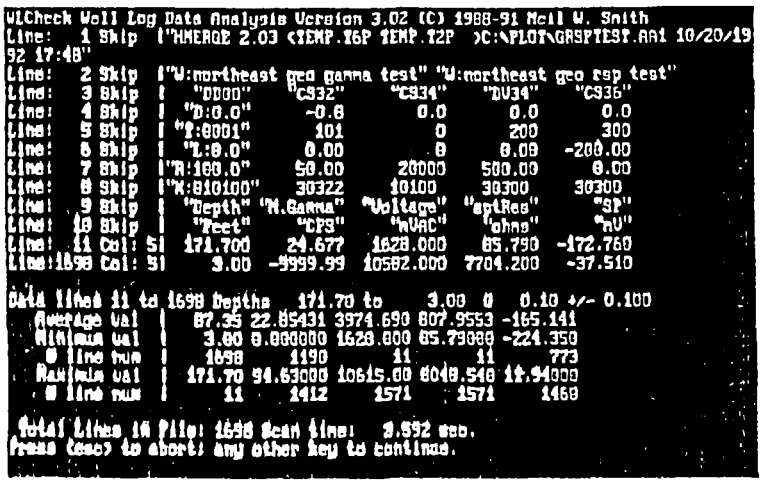


Figure 62

WlChk will provide the user with a quick statistical analysis of log data. It will produce a report to the screen or printer that lists start and end depths for the log, and maximum, minimum, and average values for each trace over that interval. If the data has depth "gaps" over a certain value, WlChk breaks up the analysis into several sets of data.

When entering WlChk, the user is presented with three options. The user can enter the value for the depth error limits that the program checks when deciding what the data set end points should be. The default value is 0.05 and should only be changed if the user has good reason to do so (large depth interval irregularities, etc.). The user then must specify where the WlChk output will be displayed. The choices are screen or printer. Printer may be selected if the user needs a hard copy of the max/min/average values to assist in re-scaling of the log. To direct the output to the printer, the user should hit select the OUTPRN selection on the WlChk submenu. To run the program, select EXECUTE. (If only a screen display of the output is desired, simply select EXECUTE when presented with the submenu).

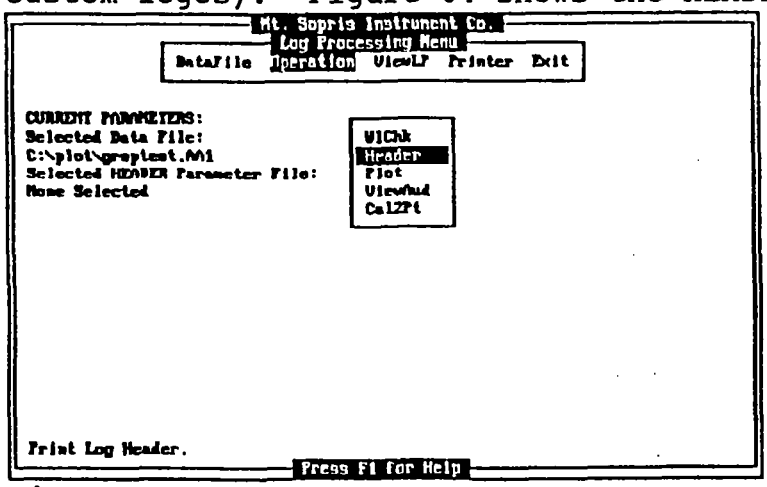
An example of a WlChk output is shown in Figure 63.



Example WlChk output

Figure 63

The next selection on the OPERATION submenu is HEADER. Several programs are called up which allow the user edit and add information to well log header files so that they can be printed out with the PRNHEAD program. In general, the user will edit and add data to "template" files already created (with or without custom logos). Figure 64 shows the HEADER selection screen.



HEADER selection

Figure 64

The user is presented with several selections when entering HEADER. The template file must be SELECTed before proceeding, or a new file can be CREATEd. Normally the user will select a pre-existing file with the form ***.HDP. When SELECT is chosen, the user will be directed to a subdirectory where the preloaded .HDP files are stored. The user can choose from several and modify and rename the output files after editing. For more information, consult the APPENDIX.

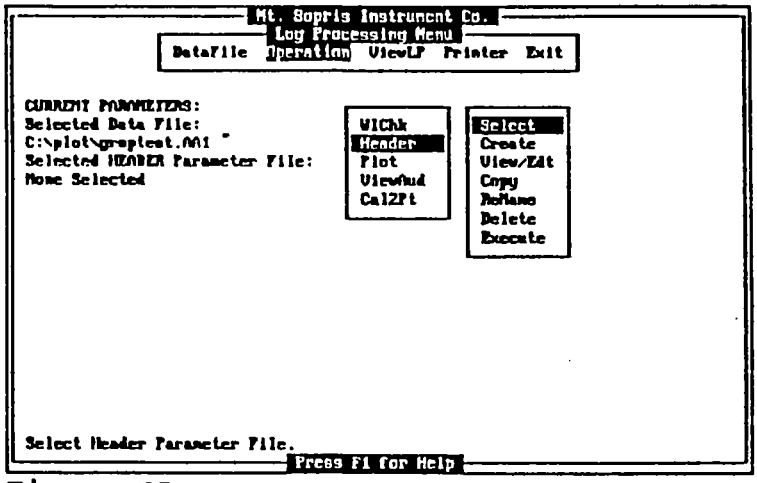


Figure 65

Header Submenu

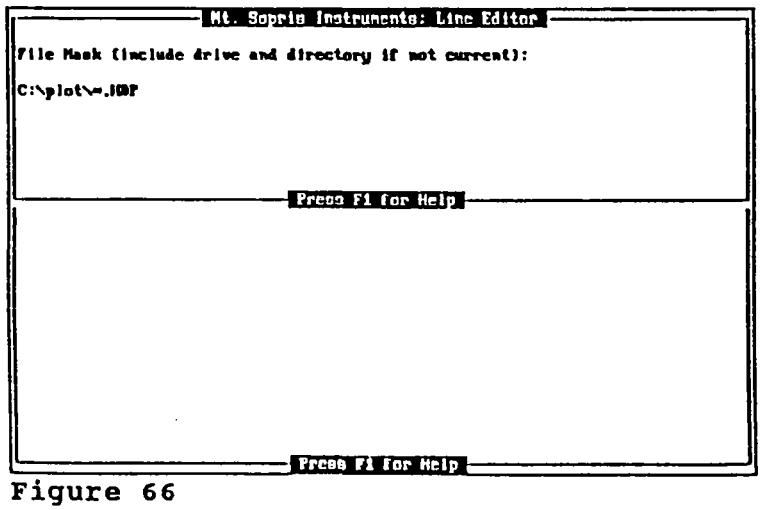


Figure 66

The .HDP files are pre-loaded in the PLOT subdirectory. The user should type <Enter> when this screen appears and a list of several .HDP type files will appear (as shown in Figure 67)

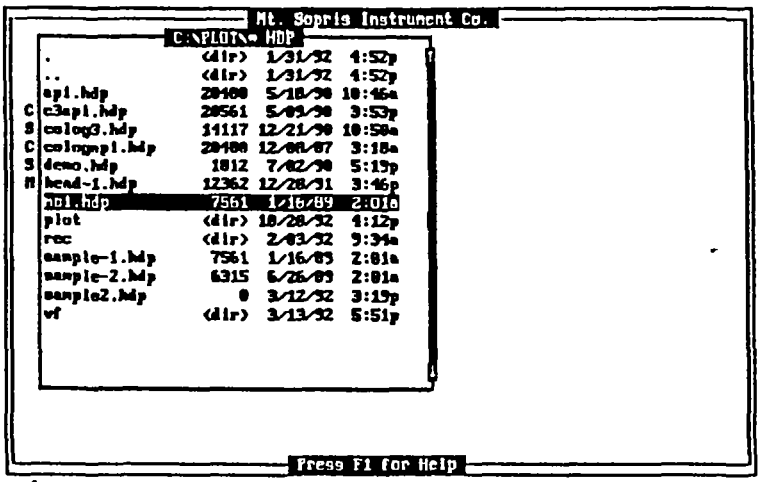


Figure 67

The user can pick from any of the files listed and experiment to find the header format that is most suitable.

Once the file is SELECTed, the user is returned to the original menu, VIEW/EDITR is selected to call up the WLHWEAD data entry screen, which allows the user to enter new log data and edit anywhere within the "shadowed" area. The user is encouraged to read the HELP file associated with WLHEAD. Additional information is included in the APPENDIX.

It is extremely important for the user to remember that the WLHEAD data entry program actually "edits" the template file and the user must copy (enter F3) the edited data into the new file or the template data will be lost. It can only be recovered by copying from the installation diskettes. Always be certain that the bottom line in the menu shows an output file name before exiting the program. When leaving the program, after all desired changes have been made, type F3, F10, and Y.

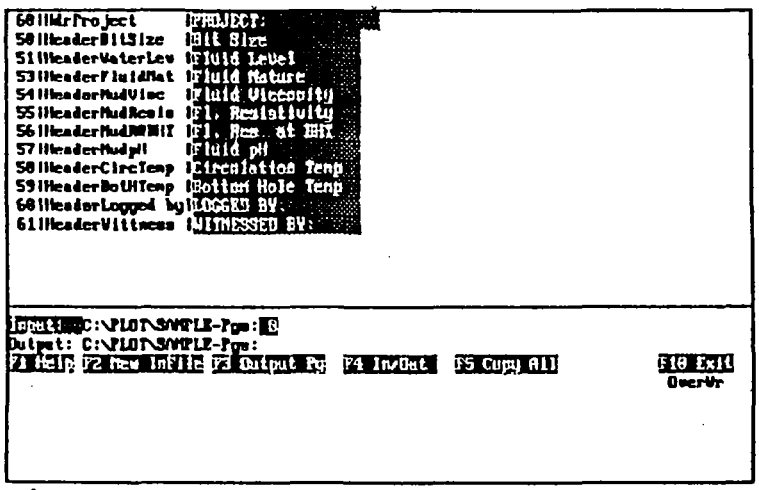


Figure 68

WLHEAD entry/edit screen. Note that the OUTPUT file is shown on the status line. This is accomplished by typing F3 after all changes are made. F10 exits the program and returns the user to the HEADER submneu.

To print the header, simply select EXECUTE and the PRNHEAD program will automatically direct the output to the printer.

The PLOT menu

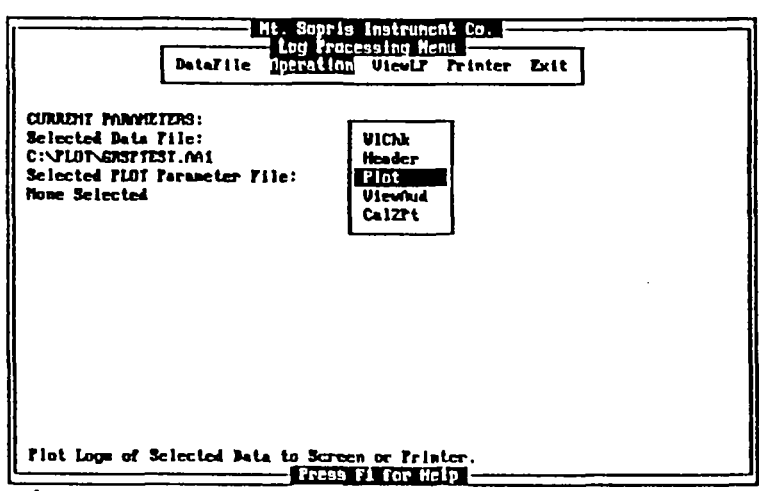


Figure 69

The next option on the CustomProcess menu is the PLOT submenu, which allows the user to direct custom plots to the display or the printer.

The PLOT submenu offers several options, but before making a plot, a plot paramter file must be selected, or created.

The PLoT parameter files contain information about scale selection, trace coding, filters, depth plotting scale, and text information. They are stored as **.PLT files and can be edited with the VIEW selection or created from scratch using CREATE.

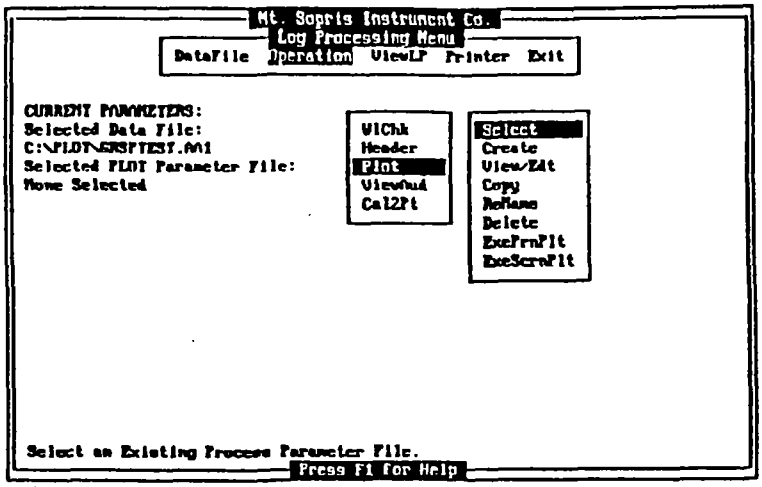


Figure 70

If the user does not have a **.PLT file already created for the data file to be plotted, the CREATE selection should be chosen.

The user will be directed into the entry screens for the header and individual trace screens, just as was done in the AutoProcess menu when plot parameters were changed for a new plot. The user will asked to name the PloT file first, and the extension will be automatically written a .PLT.

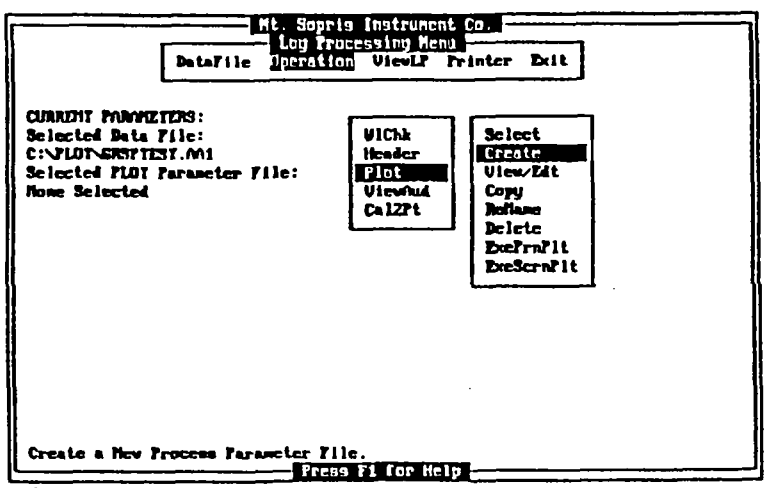


Figure 71

The PLOT CREATE menu screen

The user is asked to name the new **.PLT file. The name can be related to the data file, or could describe the type of traces included, such as GSPR, for example.

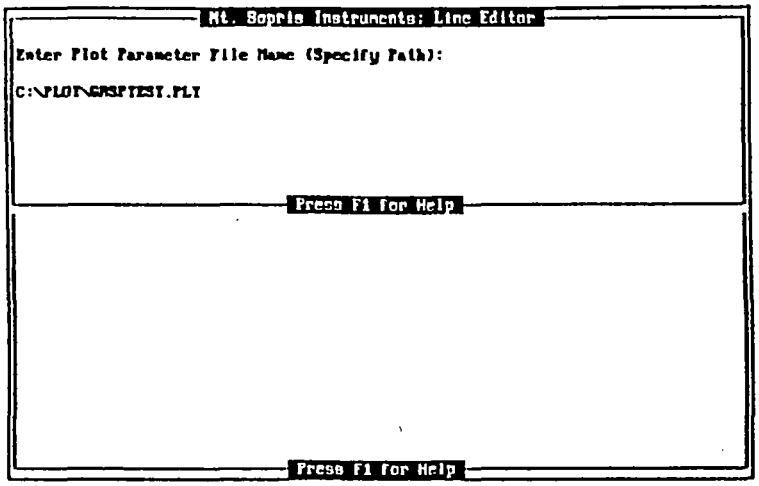


Figure 72

Once the file name is entered, the user will be asked to edit/modify the file to suit the plot parameters desired The user is reminded that the HELP screen for each entry can be accessed by typing F1 at any time during the process. Example entry menus are shown below and on the following page.

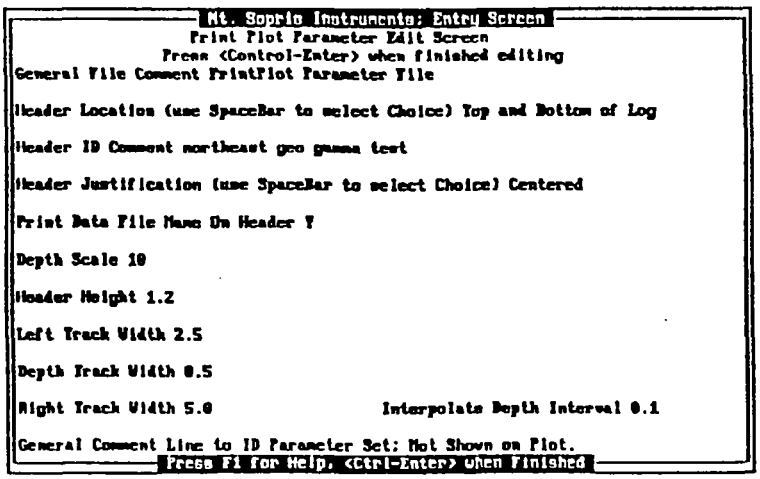


Figure 73

First Plot Parameter Entry screen

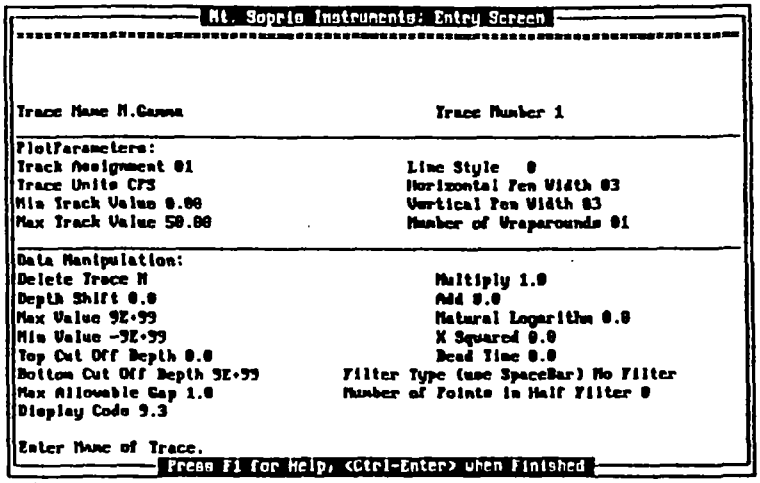


Figure 74

Example trace edit menu

The program automatically counts the number of traces and prompts the user to edit all possible traces. Scales from the original data recording are carried over in the build process and if they are suitable, will need no editing.

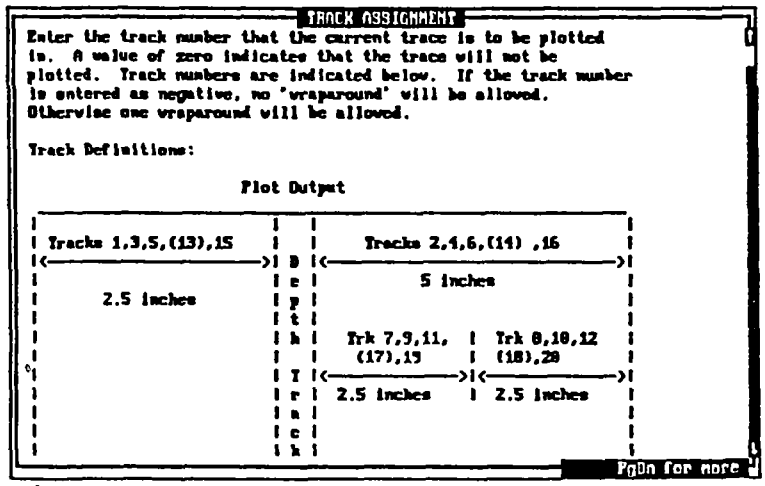


Figure 75

Help menu for Track Selection (just one example of HELP, accessed at each point by typing F1)

Remember, all entries will not need to be edited. Only those that the user wishes to change should be modified. The HELP files are useful in assisting the user in the edit process.

Once the file editing is complete, the user exits the Create program by typing <Ctrl><Enter>. **This is the <u>only</u> way to exit this menu so that the changes are <u>saved</u>.**

The user can perform the same Edit functions on existing (**.PLT) files which are chosen with the SELECT function and edited with VIEW/EDIT option.

The PLT file is then loaded into the CURRENT PARAMETERS screen area along with the selected DATA FILE. The next selection will normally be SCRNPLOT, which directs the output of the INTERP/INVERT/HMERGE programs to the screen, as in AutoProcess. Or the user may plot directly to the printer by selecting PRNPLOT.

The user will be prompted to "hit any key" to continue through the multiple program steps. As the programs must perform multiple functions and create and delete temporary files, it will take several seconds for each process. The on-screen text is provided to allow the user to view the different processes which are performed on the data in preparation for plotting.

Note: When using some portable computers, the SCNRPLOT commands <Enter>, <PgUP>, and <PgDn> may require a double key stroke to execute.

ViewAud

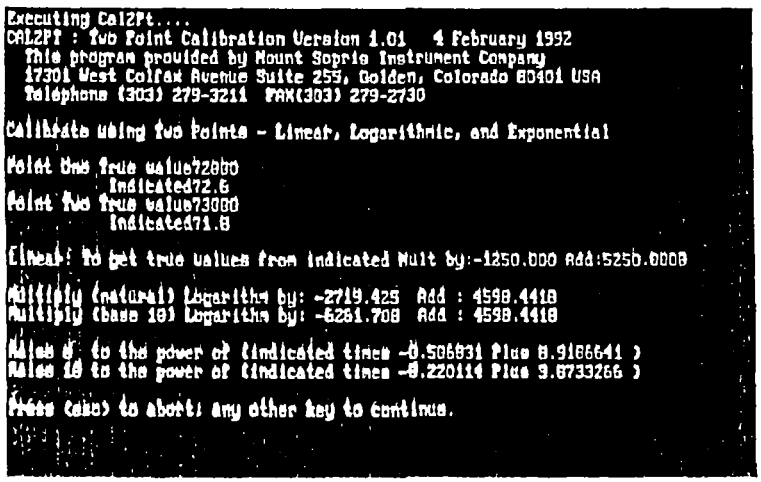
The fourth selection on the Operation submenu is ViewAud. This allows the user to View the Audit file corresponding to the selected data file. If the selected file data has been modified by any of the LOGSHELL functions (such as filters, depth shifts, etc.), the AUDIT file (in the form ???.?@? will list all program steps used to produce the final data set.

The ViewAud subroutine may be helpful in trouble-shooting data files which don't process properly.

Cal2Pt

The last selection on the Operation submenu is Cal2Pt. Cal2Pt is a simple routine used to calculate the coefficients for a liner or logarithmic conversion. These coefficients can be used directly in PRNPLOT for convering uncalibrated well log data. They can also be used in INTERP to generate a file of calibrated data.

In LOGSHELL, the program output numbers can be used when editing the **.PLT trace information to modify a data set so that a conversion from raw counts to bulk density an be produced. Other examples might include calculating neutron porosity from neutron counts. To use this feature, you must first have two calibration points to fit the data. For example, if we use gamma-gamma as our raw data (recorded in counts per second) and have two calibration points (2000 cps=2.6 gm./cc and 3000 cps=1.8 gm./cc), we can enter the Cal2Pt program with those values. See figure 76.



We could then use the calibration numbers to modify the data in the EDIT phase of PLOT in the gamma-gamma trace screen to produce a bulk density trace. Of course, the trace name and units would need to be edited to reflect the changes. See the APPENDIX for more information about Cal2Pt.

The last menu selection for the CustomProcess section is PRINTER. It acts like all other PRINTER select submenus. When this selection is made, the user is asked to accept the current printer or choose a new one. The selection obviously should correspond to the printer connected to the system.

CALIBRATIONS

The ACQSBC data acquisition program provides for simple calibration of probes requiring calibration. In general, this does not apply to pulse type tools such as natural gamma, gamma gamma, and neutron. Temperature and fluid resistivity probes are calibrated at the factory, and normally do not require field calibration.

However, resistivity, SP, and caliper probes will require calibration to account for variation in cable length, probe electronics, etc.

All calibrations are performed during in the LOG section of LOGSHELL. The following example uses a caliper calibration.

CALIPER Calibration:

Set up the LOGSHELL program so that the CLP-2380 probe is selected. It will be necessary to select a datafile name and a depth to enter the LOG procedure. Data will not be recorded in the calibration, unless the user elects to run some cable on and off the winch to drive the depth wheel. If a hard copy output of the calibration is desired, the system can be put in time drive (F5 key in ACQSBC status screen).

1. With the Status Scrren displayed, open the caliper by placing the probe select switch in MOTOR. Place the power switch to OPEN (in red) and wait until the arms are fully opened and the motor stops running, The current indicator light will go out at this point.

2. Place the small (4.5" diameter, in our example) ring on the caliper arms and center it. The best caliper calibrations are performed with the probe vertical. Change the Probe Power setting to Off. Change the Probe Select switch to Caliper. Turn the Probe Power back ON.

3. Place the cursor over the **LeftInp** value in the row marked **DV34**. Note that the double arrow marker is pointing to the caliper column in the 3rd row. This verifies that the user has selected the caliper data row. For **all** calibrations, the LeftInp field is used to set the low end calibration value of the A/D to the analog value (in this case, 4.5" diameter) being measured by the probe. Press the **F3** key to write the counter value corresponding to this ring size (InValue) into the LeftInp field. Move the cursor to **LftOut** and enter 4.5" as the analog low end calibration standard. This is the output value that corresponds to the low end A/D counter value in **LeftInp**. See figure 1 on the next page.

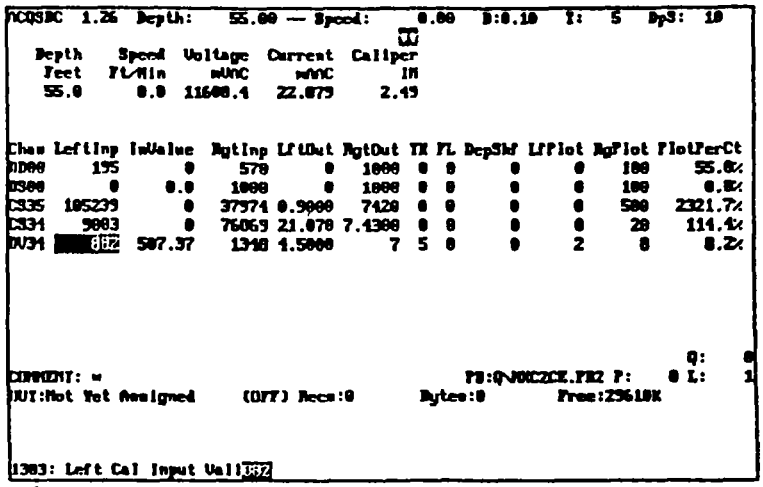


Figure 1

Calibration of the low end standard (4.5" ring in our example)

Once the LeftInp is selected, replace the small calibration ring with the large ring (7" diameter in our example). Then, place the cursor over the **RgtInp** field on row DV34 (Caliper status line) and press the **F4** key. This copies the input from the A/D counter into the high end (RgtInp) calibration point. Move the cursor to RgtOut and enter the high end analog calibration value (7"in this example).

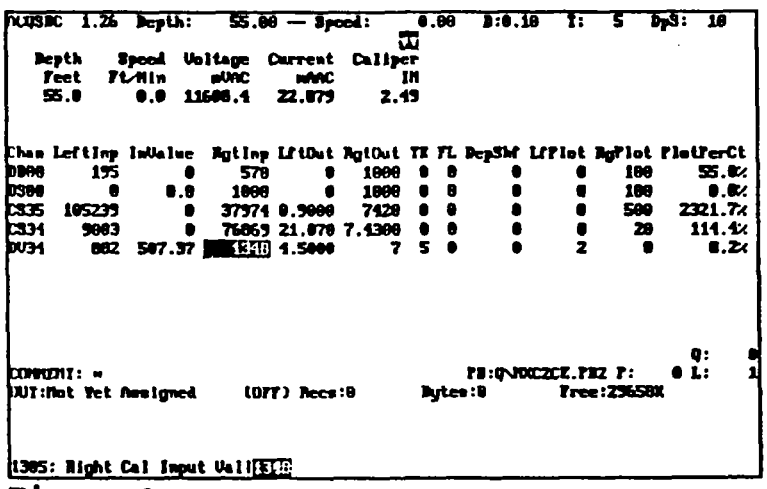


Figure 2

Calibration of the high end (7 " ring in our example)

You may wish to re-install the small ring again to verify that the value in the caliper line under the double arrow marker is accurate. If it reads slightly off, you can re-enter the LeftInp field and hit F3 to refine the low end calibration. Normally,

this should only have to be done once or twice to zero in to an accurate calibration.

Note that this calibration can be saved by hitting the F2 button. The probe file will be saved to the present PROJECT directory, so if the user wishes to re-log the caliper with this calibration, the file must be copied from the PROJECT directory to the ACQ directory.

Other Calibrations:

To calibrate SP, Single Point, and Normal Resistivity, the user should use the Mount Sopris RSP-N292 Cal Box, or provide a precision resistor and battery (along with a good digital VOM) that can be used to simulate formation resistance and SP. Once again, a low end (LeftInp) and high end (RgtInp) value will be entered in the appropriate field by using the F3 and F4 keys.

The user will need to enter the values for the high and low end analog calibration standards (for example, a 5 ohm and 500 ohm precision resistor). The SP might be -1500 mV and +1500 mV using a C cell battery (verified with a volmeter). For the HLP-2375/S strat probe, the resistors and battery are placed in series between the mud plug and the probe electrode. For the JLP-2780 normal resistivity probe, the user should refer to the operations manual and adjust for the proper K factors.

ATTACHMENT F

SHEET _____ OF _____

111 PFINGSTEN ROAD, NORTHBROOK,
ILLINOIS 60062 • (708) 272-6520

TECHNICIAN _____ SURFACE ELEV. _____

DRILLER _____ BORING STARTED _____

HELPER _____ BORING COMPLETED _____

RIG NO. _____ STATION _____

OFF SET _____ CASING USED _____ SIZE _____

WATER LEVEL OBSERVATIONS

WL: _____ WS OR WD

WL: _____ BCR _____ ACR

WL: _____ AB _____ HR. AB

WL: _____ 24 HR. AB

JOB NO. _____ **BORING NO.** _____ **CLIENT** _____ **WEATHER** _____

SAMPLE NO.	DEPTH OR ELEVATION FROM	DEPTH OR ELEVATION TO	SAMPLE METHOD	PENETRATION RECORD SPLIT SPOON BLOWS 6"	6"	6"	6" (2 FEET)	R LENGTH RECOVERED IN FEET	QP PENETROMETER TEST IN TSF	STRATA CHANGE	SAMPLE DESCRIPTION

ABBREVIATIONS

F.T. - FISH TAIL
W.O. - WASH OUT
S.T. - SHELBY TUBE
S.S. - SPLIT SPOON
D.B. - DIAMOND BIT
P.A. - POWER AUGER
R.B. - ROCK BIT
W.S. - WHILE SAMPLING
W.D. - WHILE DRILLING
B.C.R. - BEFORE CASING REMOVAL
A.C.R. - AFTER CASING REMOVAL
A.B. - AFTER BORING

DRILL CREW CHECK LIST:

TOPSOIL THICKNESS _____

FILL THICKNESS _____

CAVE IN LEVEL:

WHILE DRILLING AND SAMPLING _____

AFTER BORING COMPLETION _____

WATER LOSS:

AT _____ TO _____

PERCENT LOSS _____

AT _____ TO _____

PERCENT LOSS _____

BOULDERS OR OBSTRUCTIONS:

AT _____ TO _____

AT _____ TO _____

ARTESIAN PRESSURE:

DEPTH _____

HEIGHT OF SOIL RISE IN CASING _____

PIEZOMETER PVC OR SS

DIAMETER _____ IN.

SCREEN DEPTH _____ FT TO _____ FT

RISER PIPE _____ FT TO _____ FT

(VERSION 1: 05/91 - M11DRAW "BORING")

ATTACHMENT G

STS CHAIN OF CUSTODY RECORD

№ 17703 **RECORD NO.** _____ **THROUGH** _____

Contact Person _____
Phone No. _____
Project No. _____ PO No. _____
STS Office _____

SPECIAL HANDLING REQUEST

- ☐ RUSH
- ☐ VERBAL
- ☐ OTHER

Laboratory _____
Contact Person _____
Phone No. _____
Results Due _____

Sample I.D.	Date	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data: PID/FID Ambient	Field Data: PID/FID Sample	Field Data: PH	Field Data: Spec. Cond.	Analysis Request	Comments on Sample (Include Major Contaminants)

Collected by:	Date	Time	Delivery by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received for lab by:	Date	Time	Relinquished by:	Date	Time

Laboratory Comments Only: Seals Intact Upon Receipt ☐ Yes ☐ No ☐ N/A

Final disposition:	Comments (Weather Conditions, Precautions, Hazards):

Distribution: Original and Green – Laboratory Yellow – As needed Pink – Transporter Goldenrod – STS Project File

Instruction to Laboratory: Forward completed original to STS with analytical results. Retain green copy.

11/90 FORM 039

ATTACHMENT H

Equipment Decontamination Procedures

Decontamination of CPT downhole and soil sampling equipment will be performed between each gamma logging and soil sampling location. Decontamination will be affected on the cone equipment using a decontamination wash chamber attached to the bottom of the CPT rig. The equipment is decontaminated as it is retracted from the ground and passes though the decontamination chamber. The decontamination chamber consists of a cylinder with a rubber gasket on each end. The two gaskets will remove the soils adhering to the CPT rods. The rods then will be subject to a non-phosphate detergent (Alconox) spray wash and distilled water rinse within the decontamination chamber. An acetone rinse is available if necessary, prior to the distilled water rinse.

Wash water resulting from the decontamination of the CPT rods will be removed from the decontamination chamber through a drain port into five-gallon buckets. The water will then be transferred into 55-gallon drums until a determination is made on the type of disposal for the material.

All CPT equipment will be screened with a scintillometer (Ludlum 2220 or GM frisker) upon removal from the ground for elevated gamma radiation. Equipment exhibiting an elevated reading (average reading 20% above background readings) will be rerun through the decontamination sequence, including where possible, hand scrubbing to remove any loose material. Continued elevated readings will result in the equipment being removed from service for a thorough decontamination effort.

Other equipment which comes in contact with potentially contaminated material, such as split spoon samplers or sample handling equipment such as knives, spatulas, bowls, etc., will be subject to an Alconox and water brush washing and distilled water rinse. The washing will be performed within 5-gallon buckets. The wash waters will be screened with a scintillometer and placed in 55-gallon drums after each sampling location.

The wash waters exhibiting gamma readings above background will be stored separately from apparent background level material. Disposal of these materials is detailed in Section 3.3.2.3.

ATTACHMENT I

M.J.W. Corporation Inc.

RADIOLOGICAL CONTROL PROCEDURE 42

Controlled Copy Number _____

OPERATION OF THE EBERLINE RM-19

1.0 PURPOSE

This procedure establishes standardized operating techniques for the Eberline RM-19.

2.0 SCOPE

The RM-19 is a small, versatile alarming count rate meter with a charge sensitive input circuit and a single channel pulse height analyzer (PHA) for use with any Eberline detector. It is operated from a Gel-Cell® battery which is float charged when the unit is plugged into an AC line. Four meter ranges are provided of 500, 5k, 50k and 500k counts per minute (cpm) full scale; and a speaker with volume control provides aural indication of the count rate. The following procedure provides qualified personnel with the basic guide for using the Eberline RM-19, insures operability of the instrument and standardizes operating techniques.

3.0 RESPONSIBILITIES

It is the responsibility of personnel using the instrument to understand and follow all operating procedures. Variance from these procedures could result in nullification of results.

4.0 PROCEDURE

4.1 Instrument controls and functions for the RM-19 are as follows:

4.1.1 Switch - Six position switch turns instrument OFF, checks BATTery condition, and selects scale multipliers of 1,10,100 and 1k. This number must be multiplied by the meter reading to obtain the proper count rate.

4.1.2 Volume - Varies speaker clicks from maximum loudness to mute.

4.1.3 Push-To-Set - Allows the alarm set point to be displayed on the meter.

4.1.4 Set - Adjust the alarm set point.

4.1.5 Reset - Resets the alarm and causes the meter reading to return to zero.

4.1.6 PHA-GROSS - Switch selects either PHA (pulse height analyzer) or GROSS operation.

4.1.7 Fast-Slow Response - Switch selects either fast or slow instrument response.

4.1.8 GM-Other - Switch selects whether the RM-19 is to be used with a G-M detector or some other type of detector.

4.1.9 Detector - Connection to detector. MHV series coaxial.

4.1.10 Push-To-Read HV - Allows the high voltage reading to be displayed on meter.

4.1.11 HV Adjust - Pot to adjust the high voltage according to the use of the instrument.

4.1.12 Scaler Output - BNC series coaxial. Connection to external scaler.

4.1.13 Recorder - Connection for external 50 μA recorder.

4.1.14 Calibration Controls - One control for each range which individually calibrates that range to agree with the input count rate. Multi-turns pots located on the printed circuit board.

4.1.15 GAIN Adjust - Two controls located on the printed circuit board. One is a variable capacitor with a large adjustment range and the other is a multi-turn pot for a smaller amount of gain control.

4.1.16 THSH (Threshold): Multi-turn pot to control the window width when using the instrument in the PHA mode. Adjustable from 0 to 1 volt.

4.1.17 WIN (Window): Multi-turn pot to control the window width when using the instrument in the PHA mode. Adjustable from 0 to 1 volt always constant above the threshold.

4.1.18 HV CAL - Multi-turn pot for calibrating the high voltage meter reading to correspond to the high voltage.

4.2 Preparation for Use

4.2.1 Inspection - The instrument should be checked for physical damage.

4.2.2 Connections -

NOTE - Before using the instrument for the first time and before changing to a different type of detector, follow the instructions in the Calibration Section, 4.4, 4.4.4 or 4.4.5 to avoid damaging the detector.

4.2.2.1 Connect the cable to the instrument and the detector to the cable.

4.2.2.2 Plug the AC cord into a 115 V, 60 Hz line. AC ON light should light.

4.3 Using the Instrument

4.3.1 Starting - Turn the switch to BATTery check. The meter should indicate in the BATT OK area.

4.3.2 Operation Check - With the PHA-GROSS switch in GROSS position and the range switch on the appropriate range, place a check source in a repeatable position adjacent to the detector to achieve an upscale reading. Note that the reading is sensitive to the position of the source. The reading may be recorded for future reference.

Push the RESET button and the reading should drop to zero rapidly, then climb back to source reading when RESET is released. The RESPONSE switch may be selected for the best compromise between speed of reading and meter fluctuation.

Rotate the ALARM SET counterclockwise until alarm occurs. Alarm light should light and 1000 Hz squeal will be heard on the speaker. Push the RESET button; the alarm condition should go away until reading exceeds ALARM SET point.

4.3.3 Interpretation of Indications - The meter reading must be multiplied by the scale switch setting to obtain the proper number. The fluctuation of the meter is normal and is caused by the random nature of radioactive decay.

4.4 Calibration

4.4.1 Calibration Controls (X1, X10, X100, X1K): To calibrate these ranges, a pulse generator such as an Eberline Model MP-1 or equivalent is necessary. Capacitively couple the pulse generator to the DETECTOR connector using a capacitor with a 3KV voltage rating (in lieu of the capacitor, remove the high voltage module). The pulse generator must have a negative pulse whose amplitude is greater than 10 mV with a rise time of less than 1 μsecond, and a frequency range covering that of the instrument.

4.4.1.1 Set the RM-19 RANGE switch at X1K.

4.4.1.2 Select 400,000 cpm from the pulse generator.

4.4.1.3 Adjust the X1K CAL control (R334) for a meter reading of 400.

4.4.1.4 Set the RANGE switch to X100.

4.4.1.5 Select 40,000 cpm from the pulse generator.

4.4.1.6 Adjust the X100 CAL control (R333) for a meter reading of 400.

4.4.1.7 Set the RANGE switch to X10.

4.4.1.8 Select 4000 cpm from the pulse generator.

4.4.1.9 Adjust the X10 CAL control (R332) for a meter reading of 400.

4.4.1.10 Set the RANGE switch to X1.

4.4.1.11 Select 400 cpm from the pulse generator.

4.4.1.12 Adjust the X1 CAL control (R331) for a meter reading of 400.

4.4.2 Gain - For improved operation, always set and leave GAIN control pot R220 in the fully counterclockwise position (minimum gain). If insufficient gain is available from GAIN capacitor C201 when the GM-OTHER switch is in the OTHER position, R220 may then be used to increase gain if required for proper operation of proportional detectors.

The factory setting of input sensitivities for various detectors is now made as follows:

Proportional: 2mV, GM-OTHER switch to OTHER.

Scintillation: Approximately 10 mV, GM-OTHER switch to OTHER.

GM: 300 mV, GM-OTHER switch to GM.

No Detector Specified: 10 mV, GM-OTHER switch to OTHER.

To adjust the gain controls, the following procedure may be used:

4.4.2.1 Set the PHA-GROSS switch to GROSS.

4.4.2.2 Adjust the HV ADJust control for a reading of 2 KV on the voltmeter.

4.4.2.3 Set the pulse generator for the desired pulse amplitude (i.e., 6 mV).

4.4.2.4 Adjust GAIN controls C201 and R220 so that the RM-19 just counts the pulse generator.

4.4.3 HV CAL - To calibrate the high voltage reading on the meter to true high voltage the following procedure is recommended:

4.4.3.1 Connect an electrostatic voltmeter to the center wire on the high voltage input connector.

4.4.3.2 Adjust the HV ADJust control for a reading of 2 kV on the voltmeter.

4.4.3.3 Push the PUSH-TO-READ HV switch and adjust the HV CAL control (R329) for a meter reading of 2 kV.

4.4.4 Gross Counting - With PHA-GROSS switch in GROSS position, connect detector to DETECTOR connector. The proper setting for high voltage is to operate on the detector plateau, below the threshold of noise or unwanted radiation (see Figure 4-1). This setting is best determined as follows:

4.4.4.1 Plot a plateau (cpm vs voltage) with the detector counting the type of radiation of interest.

4.4.4.2 Plot a second plateau with the detector counting the type of radiation to be rejected (i.e., gamma for an alpha detector or normal background reading, as applicable).

4.4.4.3 From the two plateau curves a voltage is picked and the instrument is adjusted to that voltage.

CAUTION: The high voltage supply may have a voltage capability exceeding the detector rating. DO NOT turn the High Voltage ADJUST to maximum without observing either noise or plateau.

4.4.5 Pulse Height Analyzer Counting - To use the pulse height analyzer feature, the amplitude of the output pulses from the detector must be proportional to the energy of the radiation and vary with the high voltage applied.

4.4.5.1 WINdow Adjustment: The WINdow control adjusts the range of pulse heights that will be counted. The window width is expressed as a percentage of the threshold which is found by:

$$\frac{\text{Window Width (mV)}}{\text{Threshold (mV)}} \times 100 = \% \text{ Window}$$

For example, with a threshold of 10 mV, and a 50% window, the window width is 5 mV, and all pulses between 10 and 15 millivolts in amplitude will be counted.

The window width should be optimized to the particular detector and energy of interest. Figure 4-2 will aid in setting % window.

4.4.5.2 High Voltage Setting: Since the pulse height from the detector is proportional to the energy of the radiation at the detector, and high voltage varies the pulse height of the pulses, any energy can be set in the window by high voltage adjustment.

Plot a response curve (cpm vs high voltage, Figure 4-2) exposing the detector to a source of the proper energy which is intense enough to obtain a reading well above background. If background radiation makes the source counting doubtful, it may be verified by removal and replacement of the source. The energy peak can then be identified with a high voltage setting. Note that a higher energy requires a lower high voltage setting and vice versa.

5.0 DEFINITIONS

None

6.0 REFERENCES

6.1 Technical Manual for Eberline Model RM-19.

7.0 ATTACHMENTS

7.1 Figure 4-1 Typical AC-3 Response on RM-19

7.2 Figure 4-2 Typical RM-19 Response with Gamma Scintillation Detectors

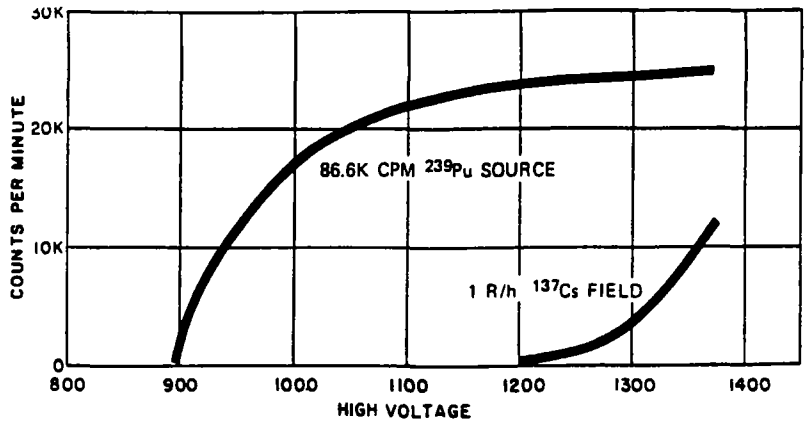
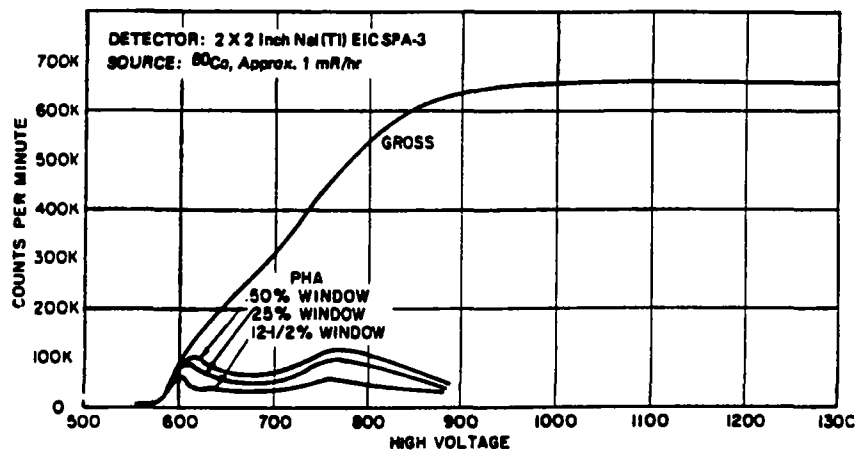
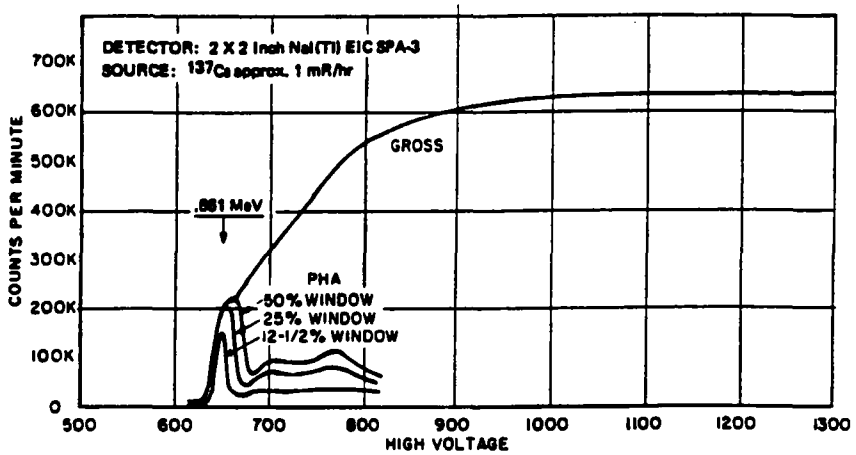


Figure 4-1. Typical AC-3 Response on RM-19

MODEL RM-19





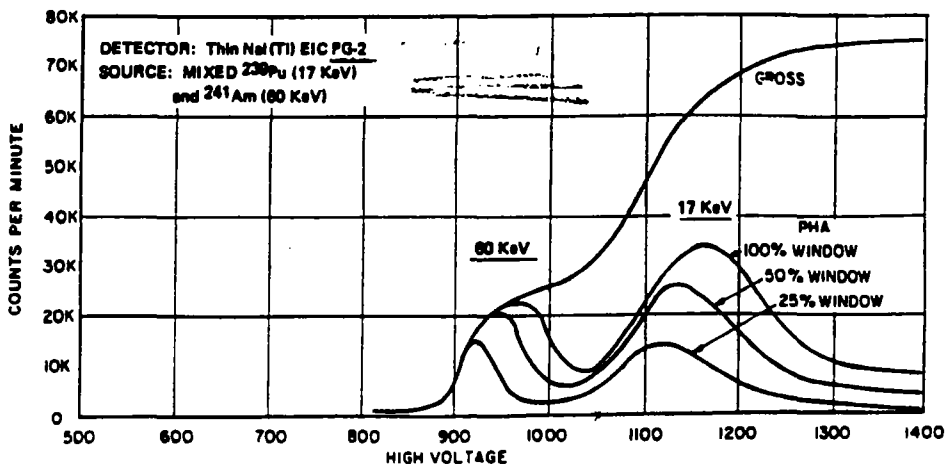


Figure 4-2. Typical RM-19 Response with Gamma Scintillation Detectors

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix A

ADMINISTRATIVE ORDER BY CONSENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION V

IN THE MATTER OF:	)	Docket No.
	)	
Lindsay Light II Site	)	ADMINISTRATIVE ORDER BY
Chicago, Illinois	)	CONSENT PURSUANT TO
	)	SECTION 106 OF THE
	)	COMPREHENSIVE
	)	ENVIRONMENTAL RESPONSE,
Respondent:	)	COMPENSATION AND
	)	LIABILITY ACT OF 1980,
The Chicago Dock & Canal Trust	)	as amended, 42 U.S.C.
	)	Section 9606(a)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JAN 27 1994

REPLY TO THE ATTENTION OF

HSE-5J

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

The Chicago Dock & Canal Trust
c/o Vincent S. Oleskiewicz, Esq.
Baker & McKenzie
One Prudential Plaza
130 East Randolph Street, Suite 3200
Chicago, Illinois 60601

Re: Lindsay Light II Site
316 East Illinois Street
Chicago, Illinois

Dear Mr. Oleskiewicz:

Enclosed please find an executed copy of the Administrative Order by Consent issued for this Site pursuant to Sections 106 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9606 and 9622. Thank you for your cooperation in this matter.

Per your letter to Verneta Simon dated January 11, 1994, please be advised that the U.S. Environmental Protection Agency ("U.S. EPA") approves STS Consultants, Ltd., MJW Corporation, and IT Corporation Laboratory as the contractors your client has chosen to undertake and complete the requirements of the Order. In addition, U.S. EPA acknowledges your client's designation of Richard Berggreen of STS Consultants, Ltd. as their Project Coordinator.

If you have any questions regarding this Order, please contact Marc Radell, Assistant Regional Counsel, at (312) 886-7948 or Verneta Simon, On-Scene Coordinator, at (312) 886-3601.

Sincerely yours,

for William E. Muno, Director
Waste Management Division

Enclosure

cc: Gary King, IEPA Superfund Coordinator

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

IN THE MATTER OF:	)	Docket No. V-W-'94-C-22
	)	
Lindsay Light II Site	)	ADMINISTRATIVE ORDER BY
316 East Illinois Street	)	CONSENT PURSUANT TO
Chicago, Illinois	)	SECTION 106 OF THE
	)	COMPREHENSIVE
	)	ENVIRONMENTAL RESPONSE,
Respondent:	)	COMPENSATION AND
	)	LIABILITY ACT OF 1980,
The Chicago Dock & Canal Trust	)	as amended, 42 U.S.C.
	)	Section 9606(a)

PREAMBLE

The United States Environmental Protection Agency (U.S. EPA) and the Respondent have each agreed to the making and entry of this Order by Consent.

It is issued pursuant to the authority vested in the President of the United States by Sections 106(a) and 122 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. Section 9606(a), as amended by the Superfund Amendments and Reauthorization Act of 1986, Pub. L. 99-499 (CERCLA), and delegated to the Administrator of the U.S. EPA by Executive Order No. 12580, January 23, 1987, 52 Federal Register 2923, and further delegated to the Assistant Administrator for Solid Waste and Emergency Response and the Regional Administrators by U.S. EPA Delegation Nos. 14-14, 14-14-C and 14-14-D, and to the Director, Waste Management Division, Region V, by Regional Delegation Nos. 14-14-A, 14-14-C and 14-14-D.

A copy of this Order will also be provided to the State of Illinois, which has been notified of the issuance of this Order as required by Section 106(a) of CERCLA, 42 U.S.C. Section 9606(a).

This Order requires the Respondent to undertake and complete emergency investigation and sampling activities to abate conditions which may present an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of hazardous substances at the Site.

FINDINGS

Based on available information, including the Administrative Record in this matter, U.S. EPA hereby finds:

1. The Lindsay Light II Site ("the Site" or "the Facility") is located at 316 East Illinois Street, Chicago, Cook County, Illinois. The Site is situated in a urban area called the Gold Coast, and is surrounded by commercial and residential buildings. A shopping mall is located approximately 200 feet to the southeast. The Chicago River is located 1 mile south of the Site and Lake Michigan is about 1.5 miles east of the Site.

2. The Site is currently a parking lot operated by General Parking and owned by The Chicago Dock and Canal Trust.

3. Until 1936, Lindsay Light manufactured incandescent gas mantels at 161 East Grand, which is .25 miles from the Site. It is unknown if they worked elsewhere; however, Sanborn maps from 1906 do show Lindsay Light being at other Chicago locations. During 1931-1936, the company moved its operations to West Chicago, Illinois.

4. The principle ingredient in gas mantle manufacture is thorium as a nitrate. Small amounts of cerium, beryllium and magnesium nitrates are also used. Thorium occurs principally as the parent radionuclide thorium-232 in association with its daughter products in a decay sequence known as the Thorium Decay Series. Thorium radionuclides are also found in the Uranium Decay Series and the Actinium Decay Series. It is believed that the principal source of contamination at this Site is the Thorium Decay Series.

5. It is unclear what Lindsay Light actually did at 316 East Illinois; however, records from The Chicago Dock and Canal Trust indicate this Site was a stable, and that Lindsay Light leased portions of the building from The Chicago Dock and Canal Trust from 1915-1933.

6. On June 3, 1993, U.S. EPA and the Illinois Department of Nuclear Safety conducted a joint investigation at the Site. This investigation verified the presence of radioactivity at levels clearly above natural background. Gamma readings were found as high as 280 uR/hr on a Ludlum Model 19 Micro-R meter. Background measured at the Site had gamma readings of 20 uR/hr.

DETERMINATIONS

Based on the foregoing Findings, U.S. EPA has determined that:

1. The Lindsay Light II Site is a "facility" as defined by Section 101(9) of CERCLA, 42 U.S.C. Section 9601(9).

2. The Chicago Dock & Canal Trust is a "person" as defined by Section 101(21) of CERCLA, 42 U.S.C. Section 9601(21).

4. Radionuclides are "hazardous substances" as defined by Section 101(14) of CERCLA, 42 U.S.C. Section 9601(14).

5. The detection of gamma rays as high as 280 uR/hr constitutes an actual or threatened "release" as that term is defined in Section 101(22) of CERCLA, 42 U.S.C. Section 9601(22).

6. The actual or threatened release of hazardous substances from the Facility may present an imminent and substantial endangerment to the public health, welfare, or the environment.

7. The actions required by this Order, if properly performed, are consistent with the National Contingency Plan (NCP), 40 CFR Part 300, as amended, and CERCLA; and are reasonable and necessary to protect the public health, welfare and the environment because of the following factors:

a. actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants or contaminants;

This factor is present at the Facility due to the existence of a public parking lot on property found to have gamma readings measured as high as 280 microroentgen per hour (uR/hr) on a Ludlum Model 19 Micro-R meter. Gamma rays are penetrating radiations indistinguishable from X-rays which can be absorbed by tissue in the human body. Furthermore, there are two parking attendants stationed at this parking lot on a 24-hour basis to collect fees, although initial readings taken on June 3, 1993, indicate that there were no levels above background where the attendants are stationed. U.S. EPA is monitoring the area to determine the potential dose. The Site is also surrounded by commercial and residential buildings, whose occupants use this parking lot and adjacent sidewalks. Situated 200 feet southeast of the Site is the North Pier shopping mall.

b. high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;

This factor is present at the Facility due to the existence of elevated gamma levels as high as 280 uR/hr on a Ludlum Model 19 Micro-R meter, as compared to 20 uR/hr for background as measured at the Site. These gamma levels may indicate higher levels in the soils because the parking lot is covered with asphalt and/or concrete, which attenuates radiation.

c. other situations or factors which may pose threats to public health or welfare or the environment.

This factor is present at the Facility due to the property's potential for future development. Such construction might entail excavating into potentially contaminated soils for placement of building footings and cause increased releases into the environment and human exposure to contaminants.

ORDER

Based upon the foregoing Findings and Determinations, and pursuant to Section 106(a) of CERCLA, 42 U.S.C. Section 9606(a), it is hereby ordered and agreed that Respondent will undertake the following actions at the Facility:

1. Within sixty (60) calendar days after the effective date of this Order, the Respondent shall submit to U.S. EPA for approval, a Work Plan for the investigation and sampling activities ordered as set forth in Paragraph 4 below. The Work Plan shall provide a concise description of the activities to be conducted to comply with the requirements of this Order. The Work Plan shall be reviewed by U.S. EPA, which may approve, disapprove, require revisions, or modify the Work Plan. Respondent shall implement the Work Plan as finally approved by U.S. EPA, including any modifications. Once approved, the Work Plan shall be deemed to be incorporated into and made a fully enforceable part of this Order.

2. The Work Plan shall contain a site safety and health plan, a sampling and analysis plan, and a schedule of the work to be performed. The site safety and health plan shall be prepared in accordance with the Occupational Safety and Health Administration (OSHA) regulations applicable to Hazardous Waste Operations and Emergency Response, 29 CFR Part 1910, and with Illinois Department of Nuclear Safety (IDNS) regulations pertaining to radiation workers, non-radiation workers, and the general public, 32 Illinois Administrative Code Part 340. The Work Plan and other submitted documents shall demonstrate that the Respondent can properly conduct the actions required by this Order.

3. Respondent shall retain a contractor qualified to undertake and complete the requirements of this Order, and shall notify U.S. EPA of the name of such contractor within five (5) business days of the effective date of this Order. U.S. EPA retains the right to disapprove of any, or all, of the contractors and/or subcontractors retained by the Respondent. In the event U.S. EPA disapproves of a selected contractor, Respondent shall retain a different contractor to perform the work, and such selection shall be made within two (2) business days following U.S. EPA's disapproval.

4. Within thirty (30) calendar days after U.S. EPA approval of the Work Plan, Respondent shall commence implementation of the Work Plan as approved or modified by U.S. EPA. Failure of the Respondent to properly implement all aspects of the Work Plan shall be deemed to be a violation of the terms of this Order. The Work Plan shall require the Respondent to perform, and complete within one hundred fifty (150) calendar days after approval, the following investigation and sampling activities:

a. Develop and implement a Site Health and Safety Plan.

b. Conduct land surveying to the extent necessary to locate all property boundaries and features, sample locations and areas having elevated radiation levels.

c. Place borings in several locations for the purpose of measuring subsurface radiation levels. Measurements shall be recorded until the natural soils are reached or radiation levels reach background, whichever is the greatest depth.

d. Collect soil samples from the borings and analyze for radionuclide content and RCRA characteristics. These results will then be used by the Respondent to correlate subsurface radiation levels and radionuclide content.

5. All materials removed from the Site shall be disposed of or treated at a facility approved by the On-Scene Coordinator and in accordance with the Resource Conservation and Recovery Act of 1976 (RCRA), 42 U.S.C. Section 6901, et seq., as amended, the U.S. EPA Revised Off-Site Policy, and all other applicable Federal, State, and local requirements.

6. On or before the effective date of this Order, the Respondent shall designate a Project Coordinator. The U.S. EPA has designated Verneta Simon, of the Emergency and Enforcement Response Branch, Response Section III, as its On-Scene Coordinator. The On-Scene Coordinator and the Project Coordinator shall be responsible for overseeing the implementation of this Order. To the maximum extent possible, communication between the Respondent and the U.S. EPA, and all documents, reports and approvals, and all other correspondence concerning the activities relevant to this Order, shall be directed through the On-Scene Coordinator and the Project Coordinator. During implementation of the Work Plan, the OSC and the Project Coordinator shall, whenever possible, operate by consensus, and shall attempt in good faith to resolve disputes informally through discussion of the issues.

7. The U.S. EPA and the Respondent shall each have the right to change their respective designated On-Scene Coordinator or Project Coordinator. U.S. EPA shall notify the Respondent, and

Respondent shall notify U.S. EPA, as early as possible before such a change is made. Notification may initially be verbal, but shall promptly be reduced to writing.

8. The U.S. EPA On-Scene Coordinator shall have the authority vested in an On-Scene Coordinator by the NCP, 40 CFR Part 300, as amended, including the authority to halt, conduct, or direct any work required by this Order, or to direct any other response action undertaken by U.S. EPA or the Respondent at the facility.

9. No extensions to the time frames in this Order shall be granted without sufficient cause. All extensions must be requested, in writing, and shall not be deemed accepted unless approved, in writing, by U.S. EPA.

10. This Order and all instructions by the U.S. EPA On-Scene Coordinator or designated alternate that are consistent with the National Contingency Plan and this Order shall be binding upon the Respondent, and the employees, agents, contractors, successors and assigns of the Respondent.

11. To the extent that the Facility or other areas where work under this Order is to be performed is owned by, or in possession of, someone other than the Respondent, Respondent shall attempt to obtain all necessary access agreements. In the event that after using it's best efforts the Respondent is unable to obtain such agreements, Respondent shall immediately notify U.S. EPA and U.S. EPA may then assist Respondent in gaining access, to the extent necessary to effectuate the response activities described herein, using such means as it deems appropriate.

12. Respondent shall provide access to the Facility to U.S. EPA employees, and U.S. EPA-authorized contractors, agents, and consultants at any time, and shall permit such persons to be present and move freely in the area in order to conduct inspections, including taking photographs and videotapes of the Facility, to do cleanup/stabilization work, to take samples, to monitor the work under this Order, and to conduct other activities which the U.S. EPA determines to be necessary.

13. This Order shall be effective on the date of signature by the Director, Waste Management Division.

14. Respondent shall provide a written monthly progress report to the On-Scene Coordinator regarding the actions and activities undertaken under this Order. At a minimum, these progress reports shall describe the actions that have been taken to comply with this Order, including all results of sampling and tests received or prepared by the Respondent and shall describe all significant work items planned for the next month.

15. Respondent agrees to retain for six years following completion of the activities required by this Order copies of all records, files and data relating to hazardous substances found on the Site, or related to the activities undertaken pursuant to this Order, whether or not those documents were created pursuant to this Order. Respondent shall acquire and retain copies of all documents relating to the Site that are in the possession of its contractors, agents and employees. Respondent shall notify U.S. EPA at least sixty (60) calendar days before any documents retained under this paragraph are to be destroyed. The documents retained under this paragraph shall be made available to the U.S. EPA upon request.

16. The United States reserves its right to seek reimbursement from the Respondent of all past costs and oversight costs it incurs with regards to the Lindsay Light II Site that are not inconsistent with the National Contingency Plan. Nothing in this Order shall be construed as a waiver of that right.

17. A notice, document, information, report, plan, approval, disapproval or other correspondence required to be submitted from one party to another under the Order shall be deemed submitted either when hand delivered or as of the date of receipt by certified mail, return receipt requested.

Submissions to the Respondent shall be submitted to:

The Chicago Dock & Canal Trust
c/o Mr. Charles Gardner, President
455 East Illinois Street
Suite 565
Chicago, Illinois 60611

Submissions to the U.S. EPA shall be submitted to:

Verneta Simon
On-Scene Coordinator
U.S. Environmental Protection Agency
77 West Jackson Boulevard, HSE-5J
Chicago, Illinois 60604

18. If any provision of this Order is deemed invalid or unenforceable, the remainder of this Order shall remain in full force and effect.

STIPULATED PENALTIES

19. For each day the Respondent fails to meet the deadlines set forth in the Consent Order and Work Plan, Respondent shall be liable as follows:

	Penalty For: First Week or Part Thereof	Each Following Week or Part Thereof
Failure to Submit the Work Plan, Site Safety and Health Plan, Sampling and Analysis Plan or the Schedule of Work to be Performed	$1,000	$1,750
Failure to Commence Implementation of the Work Plan	$1,000	$1,750
Failure to Meet any Scheduled Deadline in the Work Plan	$1,000	$1,750
Failure to Submit Monthly Reports	$ 250	$ 400

20. All penalties which accrue pursuant to the requirements of this Order shall be paid within fifteen (15) business days of written demand by U.S. EPA. Payment shall be made to the EPA Hazardous Substances Superfund delivered to the U.S. EPA, Attn: Superfund Accounting, P.O. Box 70753, Chicago, Illinois 60673, in the form of a certified or cashier's check payable to "EPA Hazardous Substances Superfund." The face of the check should note that the payment is for the Lindsay Light II Site.

21. Pursuant to 31 U.S.C. Section 3717, interest shall accrue on any amount of overdue stipulated penalties at a rate established by the United States Treasury. Stipulated penalties shall accrue, but need not be paid, during any dispute resolution period concerning the particular penalties at issue. If Respondent prevails upon resolution, Respondent shall pay only such penalties as the resolution requires.

22. Payment of Stipulated Penalties will not relieve Respondent from complying with the terms of this Consent Order. U.S. EPA retains the right to seek any remedies or sanctions available to U.S. EPA by reason of Respondent's noncompliance with the provisions of this Consent Order that are not otherwise expressly limited by these Stipulated Penalty provisions.

PENALTIES FOR NONCOMPLIANCE

23. Respondent is advised pursuant to Section 106(b) of CERCLA, 42 U.S.C. Section 9606(b), that violation or subsequent failure or refusal to comply with this Order and any Work Plan approved under this Order, or any portion thereof, may subject the Respondent to a civil penalty of no more than $25,000 per day for each day in which such violation occurs, or such failure to comply continues. In addition, failure to properly provide investigation and sampling actions upon the terms of this order, or other subsequent orders issued by U.S. EPA, may result in liability for punitive damages pursuant to Section 107(c)(3) of CERCLA, 42 U.S.C Section 9607(c)(3).

TERMINATION AND SATISFACTION

24. The Respondent shall submit a final report summarizing the actions taken to comply with this Order. The report shall contain, at a minimum: identification of the facility, a description of the locations and types of hazardous substances encountered at the facility upon the initiation of work performed under this Order, a chronology and description of the actions performed (including both the organization and implementation of response activities), a listing of the resources committed to perform the work under this Order (including financial, personnel, mechanical and technological resources), identification of all items that affected the actions performed under the Order and discussion of how all problems were resolved, a listing of quantities and types of materials removed, a discussion of removal and disposal options considered for those materials, a listing of the ultimate destination of those materials, and a presentation of the analytical results of all sampling and analyses performed and accompanying appendices containing all relevant paperwork accrued during the action (e.g., manifests, invoices, bills, contracts, permits). The final report shall also include an affidavit from a person who supervised or directed the preparation of that report. The affidavit shall certify under penalty of law that based on personal knowledge and appropriate inquiries of all other persons involved in preparation of the report, the information submitted is true, accurate and complete to the best of the affiant's knowledge and belief. The report shall be submitted within sixty (60) calendar days of completion of the work required by the U.S. EPA.

25. The provisions of this Order shall be deemed satisfied upon payment by Respondent of all sums due under the terms of this Order and upon the Respondent's receipt of written notice from U.S. EPA that the Respondent has demonstrated, to the satisfaction of U.S. EPA, that all of the terms of this Order,

including any additional tasks consistent with this Consent Order which U.S. EPA has determined to be necessary, have been completed.

INDEMNIFICATION

26. The Respondent agrees to indemnify and save and hold harmless the United States Government, its agencies, departments, agents, and employees, from any and all claims or causes of action arising from, or on account of, acts or omissions of the Respondent, its officers, employees, receivers, trustees, agents, successors or assigns, in carrying out the activities pursuant to this Order. The United States Government shall not be held as a party to any contract entered into by the Respondent in carrying out activities under this Order.

RESERVATION OF RIGHTS

27. This Order is not intended for the benefit of any third party and may not be enforced by any third party.

28. The U.S. EPA and the Respondent reserve all rights, claims, demands, and defenses, including defenses and denials of and to all determinations and findings, that they may have as to each other except as otherwise provided in this Order pursuant to any available legal authority. Nothing in this Order shall expand the Respondent's ability to obtain preenforcement review of U.S. EPA actions. Notwithstanding any reservation of rights, Respondent agrees to comply with the terms and conditions of this Order and consents to the jurisdiction of the U.S. EPA to enter into and enforce this Order.

29. Nothing herein is intended to release, discharge, limit or in any way affect any claim, causes of action or demands in law or equity which the parties may have against any persons, firm, trust, joint venture, partnership, corporation, or other entity not a party to this Order for any liability it may have arising out of, or relating in any way to, the generation, storage, treatment, handling, transportation, disposal, release or threat of release of any hazardous substance, hazardous waste, contaminant or pollutant at or from the Site. The parties to this Order hereby expressly reserve all rights, claims, demands and causes of action they may have against any and all other persons and entities who are not parties to this Order.

30. Nothing herein shall be construed: 1) to prevent U.S. EPA from exercising its right to disapprove of work performed by the Respondent; 2) to prevent U.S. EPA from seeking legal or equitable relief to enforce the terms of this order; 3) to prevent U.S. EPA from taking other legal or equitable action not

inconsistent with the Covenant Not To Sue in Paragraphs 41 through 43 of this Order; 4) to prevent U.S. EPA from requiring the Respondent in the future to perform additional activities pursuant to CERCLA, 42 U.S.C. Section 9601 et seq., or any other applicable law; or 5) to prevent U.S. EPA from undertaking response actions at the Site.

FORCE MAJEURE

31. The Respondent shall cause all work to be performed within the time limits set forth herein and in the approved Work Plan, unless performance is delayed by "force majeure". For purposes of this Order, "force majeure" shall mean an event arising from causes entirely beyond the control of the Respondent and its contractors which delays or prevents the performance of any obligation required by this Order. Increases in costs, financial difficulty, and normal inclement weather are examples of events that are not considered to be beyond the control of the Respondent.

32. Respondent shall notify the OSC within 24 hours after Respondent becomes aware of any event which Respondent contends constitutes a force majeure, with subsequent written notice within seven (7) calendar days of the event. Such written notice shall describe: 1) the nature of the delay, 2) the cause of the delay, 3) the expected duration of the delay, including any demobilization and remobilization resulting from the delay, 4) the actions which will be taken to prevent or mitigate further delay, and 5) the timetable by which the actions to mitigate the delay will be taken. Respondent shall implement all reasonable measures to avoid and/or minimize such delays. Failure to comply with the notice provision of this paragraph shall be grounds for U.S. EPA to deny Respondent an extension of time for performance. The Respondent shall have the burden of demonstrating by a preponderance of the evidence that the event is a force majeure, that the delay is warranted under the circumstances, and that best efforts were exercised to avoid and mitigate the effects of the delay. If U.S. EPA determines a delay is or was attributable to a force majeure, the time period for performance under this Order shall be extended as deemed necessary by the OSC to allow performance.

DISPUTE RESOLUTION

33. The Parties to this Order on Consent shall attempt to resolve expeditiously and informally any disagreements concerning implementation of this Order on Consent or any work required hereunder.

34. In the event that any dispute arising under this Order on Consent is not resolved expeditiously through informal means, any party desiring dispute resolution under this Section shall give prompt written notice to the other parties to the Order.

35. Within ten (10) calendar days of the service of notice of dispute pursuant to Paragraph 34 above, the party who gave notice shall serve on the other parties to this Order a written statement of the issues in dispute, the relevant facts upon which the dispute is based, and factual data, analysis or opinion supporting its position, and all supporting documentation on which such party relies (hereinafter the "Statement of Position"). The opposing parties shall serve their Statement of Position, including supporting documentation, no later than ten (10) calendar days after receipt of the complaining party's Statement of Position. In the event that these 10-day time periods for exchange of Statements of Position may cause a delay in the work, they shall be shortened upon and in accordance with notice by U.S. EPA.

36. An administrative record of any dispute under this Section shall be maintained by U.S. EPA. The record shall include the written notification of such dispute, and the Statements of Position served pursuant to the preceding paragraphs.

37. Upon review of the administrative record, the Director of the Waste Management Division, U.S. EPA, Region V, shall resolve the dispute consistent with the NCP and the terms of this Order.

NON-ADMISSION

38. The consent of the Respondent to the terms of this Order shall not constitute or be construed as an admission of liability or of U.S. EPA's findings or determinations contained in this Order in any proceeding other than a proceeding to enforce the terms of this Order.

CERCLA FUNDING

39. The Respondent waives any claims or demands for compensation or payment under Sections 106(b), 111 and 112 of CERCLA against the United States or the Hazardous Substance Superfund established by 26 U.S.C. §9507 for, or arising out of, any activity performed or expenses incurred pursuant to this Consent Order.

40. This Consent Order does not constitute any decision on preauthorization of funds under Section 111(a)(2) of CERCLA.

COVENANT NOT TO SUE

41. Upon termination and satisfaction of this Administrative Order pursuant to its terms, for and in consideration of the complete and timely performance by Respondent of the obligations agreed to in this Order, U.S. EPA hereby covenants not to sue Respondent for judicial imposition of damages or civil penalties for any failure to perform obligations agreed to in this Order except as otherwise reserved herein.

42. Performance of the terms of this Order resolves and satisfies the liability of the Respondent to U.S. EPA for work satisfactorily performed under this Order. U.S. EPA recognizes that, pursuant to Section 113 of CERCLA, the Respondent, upon having resolved it's liability with the U.S. EPA for the matters expressly covered by this Order, shall not be liable for claims for contribution regarding matters addressed in this Order. Nothing in this Order precludes the Respondent from asserting any claims, causes of action or demands against potentially responsible parties (PRPs) who are not parties to this Order for indemnification, contribution, or cost recovery.

43. In consideration of the actions to be performed by the Respondent under this Order, the U.S. EPA covenants not to sue the Respondent, its successors or assigns for any and all claims which are available to the U.S. as against the Respondent under Sections 106 and 107 of CERCLA concerning all matters satisfactorily performed.

SUBSEQUENT AMENDMENT

44. This Consent Order may be amended by mutual agreement of U.S. EPA and the Respondent. Any amendment of this Consent Order shall be in writing, signed by U.S. EPA and the Respondent and shall have as the effective date, that date on which such amendment is signed by U.S. EPA.

LINDSAY LIGHT II SITE
CHICAGO, ILLINOIS

SIGNATORIES

Each undersigned representative of a signatory to this Administrative Order on Consent certifies that he or she is fully authorized to enter into the terms and conditions of this Order and to bind such signatory, its directors, officers, employees, agents, successors and assigns, to this document.

Agreed this 10th day of January, 1994.

By _____
The Chicago Dock & Canal Trust

The above being agreed and consented to, it is so ORDERED this 27th day of January, 1994.

By _____
William E. Muno, Director
Waste Management Division
U.S. Environmental Protection Agency
Region V, Complainant

WORK PLAN FOR CHARACTERIZATION OF

RADIOACTIVE CONTAMINATION

316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

APPENDIX B

HEALTH & SAFETY PLAN

316 EAST ILLINOIS PROJECT
CHICAGO, ILLINOIS

STS Consultants, Ltd.
111 Pfingsten Road, Northbrook, Illinois

Approval: _____ _____
Craig S. Rawlinson, Senior Hydrogeologist — Date

Approval: _____ _____
David A. Dooley, STS Site Safety Officer — Date

HEALTH AND SAFETY PLAN

TABLE OF CONTENTS

HEALTH AND SAFETY PLAN

TABLE OF CONTENTS (Continued)

LIST OF APPENDICES

STS SITE HEALTH & SAFETY PLAN

SCOPE/OPERATIONAL: This plan is provided by STS Consultants, Ltd. (STS) of Chicago, Illinois, for conducting site investigations and/or cleanup work, related to hazardous substances, as defined in OSHA regulations 29 CFR 1910.120. Site activities will also be conducted to meet OSHA regulations for occupational safety per 29 CFR 1926. The focus of STS's field operations is to emphasize safety for STS personnel and others, and to minimize the potential of releases of hazardous materials to the environment. The first priority is safety.

1. SITE DESCRIPTION:

Name: 316 East Illinois Job No. C9351/2

Location: Chicago, Illinois

Approximate Size of Site: 2.6 Acres

Principal Party Contact: Charles Gardner, Chicago Dock & Canal Trust

Address: 455 East Illinois Street, Suite 565, Chicago, IL 60611

Phone: (312) 467-1870

A site-specific summary is included in Appendix B.1. Additional project contacts are provided in Appendix B.2.

2. ENTRY OBJECTIVES:

Tasks to be performed:

1) Existing Well Monitoring
2) Ambient Radiation Survey
3) Cone Penetrometer Testing & Gamma Logging
4) Drilling Borings and Soil Sampling

Duration of Site Activities: 2 Weeks

Site Access: Motor Vehicles

Expected Weather Conditions: Work will be conducted during reasonable weather.

3. SITE ORGANIZATION:

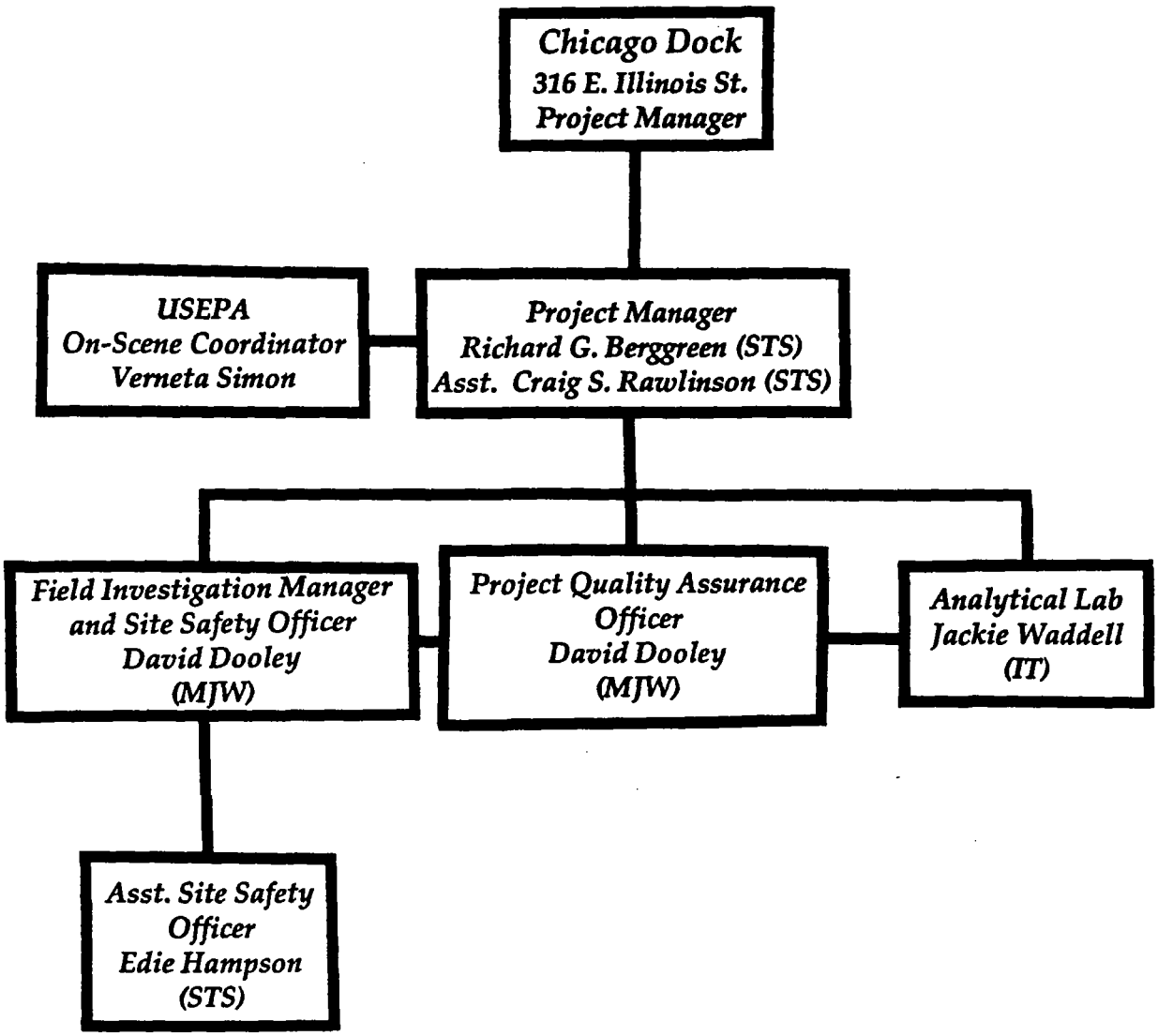
The organization of project personnel is depicted in Figure 1. The Field Investigation Manager, Dr. David A. Dooley, is responsible for coordinating and supervising on-site operations. He is responsible for ensuring that personnel: are aware of the provisions of this plan; are aware of the health and safety issues on the site; are instructed in proper work practices; have appropriate personal protective equipment available to them; and have been instructed in the proper use of the equipment. The Field Investigation Manager is a Certified Health Physicist with extensive field investigation experience.

Dr. Dooley is also the site Safety Officer and will: ensure proper coordination of site activities concerning health and safety; ensure that all personnel are familiar with site safety issues and the Health and Safety Plan; provide oversight to ensure that supervisors of the site activites are familiar with hazards and associated safety requirements; and ensure that necessary monitoring and measurements of conditions associated with hazards are performed (e.g., radiation monitoring, heat or cold stress, etc.).

All individuals are responsible for being familiar with the Health and Safety Plan. They must be aware of the hazardous materials and conditions present on the site, including being familiar with the hazards associated with their specific work assignment. Before proceeding with their work, all individuals are responsible for knowing and implementing safe work procedures, and ensuring that they work in a safe manner.

On-site STS Safety Officer: David A. Dooley

STS Safety Coordinator: David A. Dooley - Home Phone (716) 741-9467
Rich Berggreen - Home Phone (708) 480-1054
Craig Rawlinson - Home Phone (708) 367-6046



STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

PROJECT MANAGEMENT ORGANIZATION
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-23-94
CHECKED BY		
APPROVED BY	STN	2-23-94
SCALE: NTS	FIGURE NO.: 1	
STS DRAWING NO.: 27313-ZH		

Federal Agency Reps: Verneta Simon; EPA On-Scene Coordinator

Contractors On-Site: ? STS Consultants, Ltd.

Communications Available at the Site: Cellular Phone

4. HAZARD EVALUATION:

The principle of maintaining exposure levels to hazardous materials As Low As Reasonable Achievable (ALARA) shall be applied to exposures to all toxic substances, both chemical toxic materials (e.g., VOCs and PNAs) and ionizing radiation.

Intrusive type sampling work has been performed on the site. The above specifications for work are based on the information from the former activities and a reasonable conservative projection of work conditions. Each person shall be responsible:

- For placing the first priority on health and safety.
- For being familiar with the Health and Safety Plan.
- For performing only those tasks that they believe they can do safely.
- For reporting accidents or unsafe conditions to the Site Safety Officer.

Furthermore, the Site Safety Officer will be responsible for continual assessment of health and safety practices and for implementation of additional safety practices if prudent or necessary.

The substances, tasks, and associated hazards are summarized below.

Substance	Concentration	Hazards
NORM (Th, Ra) (Source Material)	Best available gamma information ≤300 µR/hr	External gamma; inhalation/ ingestion of dust or solids
Petroleum Hydrocarbons	Varying	Inhalation; ingestion; contact dermatitis
PNAs	>50 ppm	Inhalation; ingestion; contact dermatitis
Ethylbenzene, Xylene	<1 ppm	Inhalation; ingestion; contact dermatitis

MSDS Sheets attached where applicable.

TASK	ASSOCIATED HAZARDS
Drilling	Physical risks associated with drilling; exposure to source material and/or NORM, Petroleum Hydrocarbons and PNAs.
Soil Sampling	Physical risks related to equipment; exposure to contamination with source material and/or NORM, Petroleum Hydrocarbons and PNAs.
Well Water Sampling	Contact with water containing Petroleum Hydrocarbons or PNAs.
General Working	The potential for heat stress will be recognized, especially when working with protective clothing, such as Tyvek coveralls. See protection criteria for monitoring.

(e.g., Drilling, Well Sampling, Soil Sampling, etc.)

Utilities on Site: _____ _____

_____ _____

Utilities and pipelines will be identified in proposed work areas. However, the presence of unknown pipelines shall be anticipated.

The basic criteria for good hygienic work practices include no eating, no smoking, no drinking and no chewing within the work zone (e,g., subsurface work). Drinking outside the work area will be from single use containers filled from closed containers, unless otherwise specified. Drinking containers, such as coffee cups, will not be set down and reused.

4.1 General Field Safety and Standard Operating Procedures (SOPs)

- It is our policy to practice administrative hazard control for all site areas by restricting entrance to exclusion zones to essential personnel and by using operations SOPs or work plans.

- The "buddy system" will be used at all times by all field personnel in the hot zone. No one is to perform field work alone. Maintain visual, voice or radio communication at all times.

- Whenever possible, avoid contact with contaminated (or potentially contaminated) surfaces. Walk around (not through) puddles and discolored surfaces. Avoid kneeling or setting equipment on the ground in the exclusion zone unprotected. Stay away from any waste drums unless necessary. Protect equipment from contamination by bagging.

- Eating, drinking, smoking or chewing is permitted only on designated areas in the support zone.

- Hands and face must be thoroughly washed upon leaving the exclusion area.

- Beards or other facial hair that interferes with respirator fit will preclude admission to the exclusion zone.

- All equipment must be decontaminated or discarded upon exist from the exclusion zone, as determined by the Site Safety Officer or designate.

- All personnel exiting the exclusion zone must go through proper decontamination procedures if found to be contaminated.

- Proper safety equipment will be required for all field personnel.

4.2 General Decontamination Procedures

In general, everything that enters the exclusion zone at this site, must either be decontaminated or properly discarded upon exit from the exclusion zone. All personnel, including any state and local officials must enter and exit the exclusion zone via the step-off pad. Prior to demobilization, contaminated equipment will be decontaminated and inspected by the Site Safety Officer or designate before it is moved into a clean area. Any material that is generated by decontamination procedures will be stored in a designated area until disposal arrangements are made.

All personnel must sign the "Exclusion Zone Entry/Exit Log" when entering and exiting the exclusion zone.

NOTE: The type of decontamination solution to be used is dependent on the type of chemical hazard. The decontamination solution for this site is TSP soap and water. Decontamination solution will be changed daily (at a minimum) and collected and stored on-site until disposal arrangements are finalized.

4.3 General Procedures for Equipment Decontamination

Following decontamination and prior to exit from the hot zone, the Site Safety Officer (or a designated alternate) shall be responsible for ensuring that the item has been sufficiently decontaminated. This inspection shall be included in the site log.

4.4 Operational Controls, Exposure Limits

The following operational controls shall be used for work at the site. Criteria for radiation exposure rates and concentrations of chemical hazards are based on general area measurements where people are exposed, no localized areas where people would not be present for other than very short periods of time (e.g., several minutes). These controls are predicated on the principles of ALARA. The principle of ALARA shall be applied to exposures to all toxic substances, both chemically toxic materials and radiation.

The following measuring instruments will be used for sampling operation:

- Volatile Organic Compound Detection Instruments:
  - H-Nu or Photovac MicroTip photoionization detector instruments (PID). Instruments shall be calibrated with a span gas daily and zeroed where measurable concentrations of volatile organics do not exist.

- Radiation Detection Instruments:
  - TLD dosimeters for external gamma; provide integral measurement for each person.
  - **Direct-Reading Dosimeters (DRDs) - for daily tracking of personnel external dose.**
  - External gamma radiation: Calibrated survey instruments with tissue equivalent plastic scintillation detectors that provide results in µRem/hr (e.g., Bicron MicroRem LE). Other units may be used, results of which can be converted to µRem/hr (e.g., Ludlum Model 3 or Model 2220 instruments with Ludlum Model 44-10 detector, or equivalent). Equivalent radiation instruments using G.M. or other detectors can also be used. Instruments shall be checked daily with a field check source.
  - Surface contamination shall be measured with G.M. pancake probes or equivalent detectors (thin window, sensitive to beta and alpha radiation). Instruments shall be calibrated with a traceable Cl-36, Sr-90, or other beta source, and checked daily with a field check source (for example, Ludlum Model 2220 with Model 44-9 probe).

The following "operational controls" shall be used for all field investigation activities. Activities may be conducted using more limiting controls and more protective personal protective equipment (PPE) if the Site Safety Officer specifies such. The control limits are summarized in Table 1. A summary of information on the toxic materials is given in Appendix B.3.

A. Radiation Exposure: The following criteria reflect ranges of exposure rates, where the stated value is the lower value of the range and the value at which the specified controls will be implemented:

- Surface Contamination: The potential for contamination of personnel with source material and/or NORM will be minimal if any. However, all personnel who have had direct contact with radioactive or potentially radioactive materials shall be monitored for safe contamination prior to leaving the decontamination zone. Measurements should be made in a low-background area, where the background on a G.M. pancake probe is about 50 counts per minute (CPM) or less. Surface contamination on personnel shall be essentially background for unrestricted release and should explicitly be less than twice background.

  Personnel with any removable contamination on their skin shall be decontaminated immediately and the principal of ALARA applied. As a general rule for this type of work, if visible dirt is not present, contamination will not be present either. The same criteria applies to equipment. All soil sampling equipment shall be monitored before release from the site (e.g., drill rig and drilling equipment).

The following requirements apply to work within the exclusion zone:

- All STS and subcontractor personnel shall wear TLDs (radiation dosimeters) between the waist and the shoulders with the TLD facing outward.

- The exclusion zone will be posted as a "Radioactive Materials Area" during all intrusive work.

- General Area Exposure Rate <400 µR/hr: Work can be performed at Level D, unless there are other constraints. Work should be planned and work plans implemented to minimize occupancy in areas with exposure rates above 200 µR/hr. Radiation monitoring should be performed prior to, midway through and at the completion of all work shifts. Continuous monitoring will be required for all intrusive work. Workers leaving the area will be surveyed for surface contamination and decontamination will be performed as necessary. Protective clothing (e.g., Tyvek) is not specifically

required.

- General Area Exposure Rate >400 µR/hr: Occupancy of the work area should be minimized. General area radiation measurements should be taken every two hours during work and the need for Tyvek or equivalent coveralls to control contamination of personal clothing should be considered based upon contamination surveys during the work evolution.

- General Area Exposure Rate >1000 µR/hr: Occupancy of the area will be limited by planning work. Personnel not required for the work should not be present. The use of protective clothing should be considered, but respiratory protection will generally not be required, unless there are confined spaces where radon may have accumulated or there is considerable airborne dust. Radiation measurements will be recorded prior to work at one hour intervals and at the completion of work.

- General Area Exposure Rate >2500 µR/hr: Areas will be marked with a brightly colored tape and special permission from the Site Safety Officer will be required for occupancy for over 40 minutes. The need for protective clothing (e.g., Tyvek and gloves) and for respiratory protection will be specifically determined by the Site Safety Officer. Work will be planned to minimize the required occupancy time and occupancy will be specifically limited to prevent unnecessary radiation exposure.

Regardless of the external exposure rate, the work effort will be continuously monitored for radiation and contamination levels. Continuous radiation protection coverage is the only way to ensure that individual and collective exposures are maintained ALARA.

It should be noted that the likelihood of being exposed to airborne particulates during this type of work is at best remote. This is due to the fact that the soil is normally moisture laden and is thus non-disperable. Further, soil removed as samples or for

other purposes which contains radioactive material will not be left out to dry and thus become potentially disperable.

B. Volatile Organics: Monitoring for volatile organic airborne concentrations shall be performed using H-Nu and/or MicroTip PID instruments. Field monitoring should consider both the response of a technique to benzene and also the presence of other materials and the associated response of the measurement technique. PID monitoring instruments can use different excitation lamp voltages to vary the relative response to different materials and different span gases can be used to calibrate the instruments. Isobutylene is the common span gas and the common lamp voltage is 10.6 eV for the MicroTip. A PID detector with a lamp voltage of 10.6 eV, calibrated with isobutylene, provides and over-response of about 1.78 for benzene and 1.91 for toluene. Benzene and toluene were not detected in soil or groundwater in samples for the STS 1992 investigation and are not expected to be present.

The following controls are based on having no adverse effects from the toxic materials. However, given variations in personal susceptibility and uncertainties of monitoring, it is furthermore required:

If a person exhibits acute effects relatable to the subject toxic materials; such as nausea, headaches, eye irritation, they will leave the area immediately. The need for a higher level of PPE will be considered by the Project Manager and the Site Safety Officer, based on the observed conditions and monitoring results.

- 10 to <15 ppm VOC: If monitoring results for volatile organic compounds are above 10 ppm (e.g., PID, or equivalent), monitoring will be performed continuously and workers should stay upwind of the drill hole.

- 15 ppm VOC: If monitoring results for volatile organic compounds are above 15 ppm (e.g., PID, or equivalent), work shall be performed at Level B. Cartridges shall be changed at each work break. Monitoring shall be performed continuously during work, and to the extent reasonably achievable, workers should stay upwind of the drill hole.

- 15 ppm to 50 ppm VOC: Work will be performed in Level C with air-purifying respirators with appropriate cartridges or more protective equipment. The airborne concentration of VOCs will be continuously monitored. Cartridges shall be changed at each work break. The potential of off-site airborne releases and exposures to people using the parking lots will be evaluated. Consideration will be given to revising work procedures to reduce airborne releases or terminating work.

- $\geq$ 50 ppm VOC: Work will be performed in Level B with positive pressure demand air-supplied respirators. Monitoring for VOCs will be performed continuously and unnecessary personnel will be excluded from the area. Level B protection is sufficient for up to about 500 ppm.

- $\geq$ 100 ppm VOC: Work will be temporarily terminated at 100 ppm VOC for the general area. Work will continue for readings $\geq$ 100 ppm which area localized at the drill hole.

B. Heat stress is of special concern when using protective clothing that decreases the body's ability to cool itself. Heat stress can be controlled by taking breaks, drinking adequate liquids, proper clothing, using showers to cool people, etc. If heavy continuous physical activity is required, heat stress monitoring will begin when the ambient temperature exceeds about 70°F, and specific monitoring procedures will be applied at temperatures above 80°F.

Above 80°F, with strenuous activity, breaks will be taken about every half hour. The breaks will be taken where people can cool off. Heat-stress monitoring will include measurements of the loss of body weight and possible monitoring of the temperature of the ear canal. Close observation will be provided if weight losses exceed one (1) percent and/or core body temperature exceeds 99°F. Individuals with a weight loss of over 2 percent and/or core temperature of >100°F will temporarily be removed from work requiring wearing coveralls or respirators.

5. PERSONAL PROTECTION EQUIPMENT/CLOTHING (PPE) REQUIREMENTS:

Normal Field Clothing: Full-length pants, stout shoes, and gloves (available as needed) are required. Disposable nitrile gloves should be worn for collecting samples.

Additional PPE requirements:

Hard Hat	Around drill rig, backhoe or other heavy equipment
Safety Shoes	On Site
Safety Glasses	On Site
Tyvek Coveralls	If >1000 µR/hr and significant contamination levels (>1000 dpm/100 cm^2) are present.
Breathing Protection	If VOCs >15 ppm
Eye Wash	Available at Site
Other (Specify)	

6. ON SITE CONTROL

Site Plan/Activity Zones: A site map is given in Figure 2. The undisturbed site exhibits low levels of contamination that is well-contained, presenting minimal concern for personnel contamination. Disturbed areas of the site, such as locations where drilling is being done, pose potential for contamination of personnel or equipment with hazardous substances. The following activity zones are denoted:

Exclusion Zone: Exclusion zones or exclusion areas are denoted as the area within 5 meters of subsurface investigations. "Control" of area entrance and egress will be via a single control point using a step-off pad. The step-off pad will be strategically located to avoid interference with activities of the general public.

Decontamination Zone: The need for decontamination zones is not anticipated and specific areas are not designated. There will be sufficient decontamination of equipment and personnel within the exclusion area to prevent the spread of contamination. If necessary,

decontamination zones will be designated. Final decontamination of sampling equipment will be performed at the pad. The location of the pad will be based on site conditions. No specific area on the site will be designated as a decontamination zone with a hot line.

Evacuation Gathering Point: This area will be located at least 100 ft from the site where personnel are to gather after an emergency evaluation. This area should be in a predominant upwind direction from work areas if there are airborne releases. The northwest corner of the site is designated as the "Gathering Point," unless another area is specifically designated during site operations by the Safety Officer.

7. ENVIRONMENTAL MONITORING:

The following environmental monitoring instruments will be used on site at the specified intervals (cross out if not applicable):

PID (MicroTip)	~~continuous~~ ~~hourly~~ ~~daily~~	other	Intermittently during activities*
Radiation Meters	~~continuous~~ ~~hourly~~ ~~daily~~	other	Intermittently during activities
TLD	continuous ~~hourly~~ ~~daily~~ ~~other~~		All trained personnel and site visitors
Air Sampling	~~continuous~~ ~~hourly~~ ~~daily~~	other	Intermittently during activities

***The PID monitoring should be continuous while drilling is occurring.**

8. EMERGENCY RESPONSE:

LOCAL EMERGENCY INFORMATION (Default: Call 911)			
AGENCY	**PHONE**	**ADDRESS**	**CONTACT**
Police	911		
Fire	911		
Hospital	943-6600	333 East Huron St.	
Poison Control	(800) 442-2704		

SLC Medical Contact:

Name: **Northwestern Memorial Hospital**
233 East Superior (Olson Pavilion)
Emergency Phone: (312) 908-5222
Non-Emergency Phone: (312) 908-2000

Emergency Response Route: 5 blocks north of the site.

Emergency Procedures/Evacuation: Unless otherwise indicated below, emergency conditions, requiring evacuation are not anticipated. However, unforeseen events may require evacuation. The signals for evacuation include a verbal signal and a hand signal indicating evacuation (a short and hand signal, repeated twice, to leave), or three two second signals on a vehicle horn, repeated after a 5 second pause.

Emergency Response Plan: The following items denote the emergency response plan. Action items will be implemented prior to work on the site:

a. Chain-of-Command: Safety officer, and at least one, preferably two alternates, with specified authority.

David A. Dooley - STS Site Safety Officer
Work: (716) 631-8291 Home: (716) 741-9467

Edie Hanpson - STS Corporate Health & Safety Officer
Work: (708) 272-6520 Home: (708) 295-8847

Richard Berggreen - Project Coordinator
Work: (708) 272-6520 Home: (708) 480-1054

b. Emergency Types of Conditions and Required Actions: Concerns and actions for physical safety override concerns of minor spread of contamination or minor over exposure to toxic materials. However, proper response to these conditions requires planned and knowledgeable actions. For example, a person shall not remove respiratory protection in an oxygen deficient area or enter an oxygen deficient area without an SCBA to help someone else. However, such protection may be reasonable removed in intermediate radiation exposure areas if necessary to assist another person.

For example:

- Take immediate action to respond to life-threatening injuries and indications of acute sickness (e.g., heart attack).

- Leave areas of potential exposure immediately if there are symptoms of headache, dizziness, nausea. See medical attention expeditiously if these symptoms can be related to exposure to subject hazardous substances.

- Evacuate area immediately if there are indications of unknown gaseous clouds, known toxic gaseous clouds, fires, etc.

- Evacuation should be performed via the step-off pad in the exclusion zone, unless more expedient evacuation is prudent. If people have evacuated without radiation monitoring, the presence of potential contamination should be noted. Reasonable decisions made concerning providing required medical treatment or first performing decontamination. Once the emergency situation is under control, all personnel in the Evacuation Gathering Point shall be whole body frisked and proceed to a designated clean area. The evacuation area and evacuation route will be cordoned off, and surveyed. The route will be decontaminated as necessary.

The types of emergencies directly related to the site activities anticipated to occur are:

- Physical and Equipment Accidents Related to the Drill Rig: Accidents to personnel may require immediate first aid and possible obtaining emergency response from local 911. The route to the hospital is included as Figure 3, if a person can be transported to the hospital by site personnel.

  Potential accidents associated with the drill rig include: rupture of a fuel tank or hydraulic line, drilling into underground utilities, and hitting overhead lines with the boom. If such events occur, personnel will first be concerned with personnel safety, and then focus on containment of fluids, and recovery of the material. The priority should be on personnel safety.

- Acute Effects From Exposure to PNAs and/or Hydrocarbons: if there are indications of significant exposures or acute effects from exposures to toxic substances, immediate notification shall be made to 911 for emergency services. Depending on projected response times and the persons physical conditio, the person shall be taken to the hospital for treatment and/or observation. Even if the acute effects do not appear to be significant, the person shall be taken to the hospital for overnight or longer observation, to ensure the availability of emergency medical services if they are required.

STS SITE HEALTH AND SAFETY PLAN

I have read the STS Consultants, Ltd. Site Health and Safety Plan for work at the _____ site and are familiar with its provisions.

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

NAME:_____ DATE:_____

APPENDIX B.1

316 EAST ILLINOIS SITE

316 EAST ILLINOIS SITE

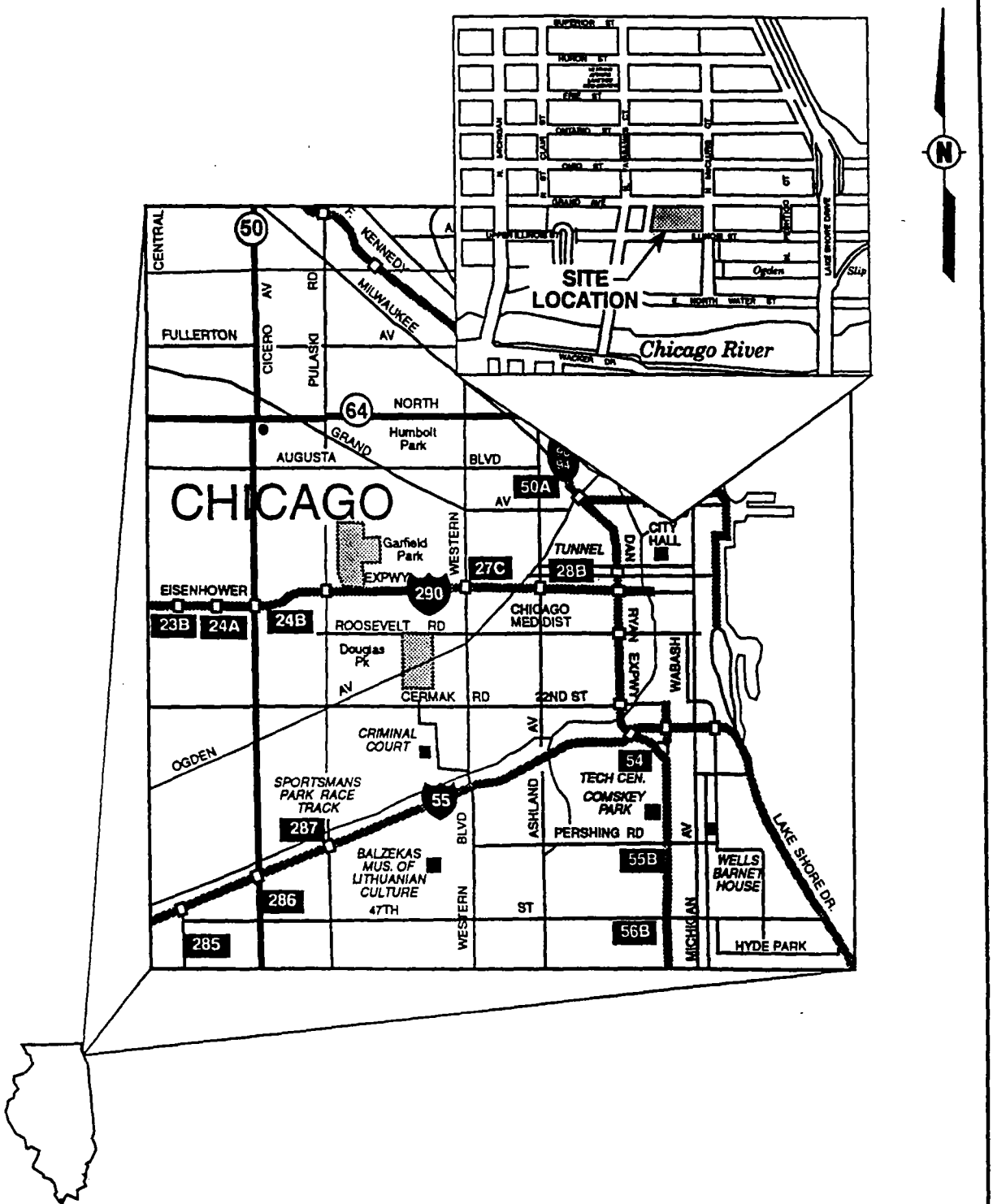
1. INTRODUCTION

1.1 PROJECT DESCRIPTION AND BACKGROUND

The Chicago Dock and Canal Trust Property (Chicago Dock), at 316 E. Illinois Street, generally extends between East Illinois Street on the south to Grand Avenue on the north. It is bounded by Columbus Drive on the west and McClurg Court on the east. Figure C-1-1 is a location map, indicating the location in the state of Illinois and the City of Chicago. The U.S. Environmental Protection Agency (EPA) has measured elevated gamma radiation levels on portions of the site and has designated the site as Lindsay Light II. The site, which was leased to Lindsay Light prior to about 1933, is denoted herein as "the property". The property is presently undeveloped and has been used as a parking lot in recent years. The lot, operated by General Parking Company, is paved with asphalt with a crushed stone base and has steel guard rails to border the parking lot.

Chicago Dock and Canal Company was founded in 1857. Chicago Dock and Canal Trust, the direct successor, is a real estate investment trust formed in 1962. Both companies are included in the reference to "Chicago Dock," Chicago Dock records indicate that the property was leased to Lindsay Light from about 1915 to 1932. Chicago Dock records also indicate that the property from 216 to 322 East Illinois Street was rented by Cooper's Stable prior to 1913 until 1914 or later. A 2-story building on the site housed a stable for horses and wagons and a blacksmith shop.

In 1914 the Cooper Stable was divided in half, from east to west. The south half fronting on Illinois Street at 316 E. to 322 E. was leased by Lindsay Light. Chicago Dock's records indicate that Lindsay Light made rent and tax payments on this property until about 1932. The building was demolished around 1933, which is consistent with the cessation of rent payments by Lindsay Light.



STS Consultants Ltd.
Consulting Engineers

PROJECT/CLIENT

316 E. ILLINOIS LOCATION MAP
CHICAGO DOCK & CANAL
316 E. ILLINOIS STREET
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-22-94
CHECKED BY		
APPROVED BY	STN	2-22-94
SCALE: NTS	FIGURE NO.: C-1-1	
STS DRAWING NO.: 27313-ZH		

The activities covered by this Health and Safety Plan focus on characterizing the radioactive materials that may be residuals from the Lindsay Light activities at the property. Review of property records indicates that Lindsay Light performed its primary manufacturing operations in this area of Chicago at 161 E. Grand Avenue, about one-quarter mile west of the property. The perception is that the manufacturing operations were performed at 161 E. Grand Avenue, and that the 316 E. Illinois Street site was used as a warehouse site and as a stable to provide support services for transporting material to and from the main site.

A site investigation by STS Consultants Ltd. (STS92; STS Project No. 27313-XH), July 1992, indicates that prior to the presence of Cooper's Stable and Lindsay Light, there were industrial and manufacturing activities at the property that date back to about 1900. These activities apparently included a metal polishing plant, a carbonic acid manufacturer, and a lubricating oil plant with underground storage tanks.

The STS investigation included digging several test pits, installing four (4) shallow groundwater monitoring wells, and drilling numerous borings to obtain soil samples. The results of the STS investigation indicated petroleum spread over an area of approximately 24,000 square feet of the general site. The presence of petroleum appeared to be vertically centered on the water table at a depth of about 13 ft. The petroleum appeared to extend about 4 ft below and above the water table, but there was no measurable thickness of petroleum residue floating on the water table in the monitoring wells.

The following items summarize the results of the STS investigation.

- There was no radiation monitoring performed and samples were not analyzed for radioactivity.

- Petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PNA) were present in many samples. The detection of volatile organic compounds (e.g., xylene and/or ethylbenzene), indicates the presence of petroleum products; probably diesel, heating, or heavy lubricating oil. Benzene and toluene were not detected in the soil or water samples. The measured concentrations and total xylenes and ethylbenzene, the other constituents of BTEX, were less than 1 ppm (parts per million or mg per kg).

- Trace levels of several chlorinated solvents compounds (e.g., tetrachloroethene, trichloroethene, and tetrachloromethane) were detected in three test pit samples. However, the concentrations were at the trace level, and were not present in borings or groundwater samples. The identified concentrations were less than 1 ppm.

- No detectable levels of PCB or heavy metals were observed in the soil or groundwater samples. However, total lead concentration in water exceeded the EPA MCLs in three of the monitoring well samples and the chromium MCL was exceeded in one of the four well samples.

- The concentrations of TPH and PNAs ranged from 22 to over 15,000 ppm.

Investigations of records for the site indicate that there may be residuals of radioactive material from Lindsay operations and petroleum related contaminants from prior activities. Radiation surveys performed by EPA and Illinois Department of Nuclear Safety (IDNS) on June 3, 1993, indicated radiation readings as high as 280 μR/hr on localized areas of the property, compared to a measured natural background using similar survey equipment of about 20 μR/hr. These elevated radiation measurements may be due to residuals, containing thorium and radium, from the Lindsay Light operations.

APPENDIX B.2

316 EAST ILLINOIS PROJECT CONTACTS

APPENDIX B.2

316 EAST ILLINOIS PROJECT CONTACTS

Position	Name	Location	Phone
STS Project Coordinator	Richard Berggreen	Office Home	(708) 272-6520 (708) 480-1054
STS Project Manager	Craig Rawlinson	Office Home	(708) 272-6520 (708) 367-6046
STS Corporate Health and Safety Officer	Edie Hanpson	Office Home	(708) 272-6520 (708) 295-8847
STS Site Safety Officer	David A. Dooley	STS Office Office Home	(708) 272-6520 (716) 631-8291 (716) 741-9467
Hospital			
Veterans Affairs Lakeside Medical Center		333 East Huron St.	(312) 943-6600
Chicago Dock Contacts			
President	Charles Gardner	Chicago Office	(312) 467-1870

APPENDIX B.3

MATERIALS PROPERTIES

MATERIAL PROPERTIES

This appendix provides brief summaries of health and safety information on the toxic materials present at the 316 East Illinois Site. The information on chemically toxic materials is primarily taken from I. Sax and R. Lewis, Rapid Guide to Hazardous Chemicals in the Workplace, Van Nostrand Reinhold Company, 1986 and "The NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, 1990. The information on the risks associated with radiation exposure is taken from the National Council on Radiation Protection and Measurements, Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," and the National Research Council, "Health Effects of Exposure to Low Levels of Ionizing Radiation, "BEIR V, National Academy Press, 1990.

The following items describe the nature of risks and effects of exposures to the various materials:

NORM - Naturally occurring radioactive material (NORM) represents the same type of material as is present in natural rock and soil. There will be no acute health effects from exposures to the low-levels of radioactivity associated with the NORM at the site. The radiation exposures to workers will be less than the yearly exposure to natural background radiation (i.e., due to natural radioactivity in soil, cosmic radiation from space and radon). Expected radiation exposures will be a small fraction of the occupational regulatory limits of OSHA (29 CFR 1910), the U.S. Nuclear Regulatory Commission (10 CFR 20), and the Illinois Department of Nuclear Safety (Title 32, Part 340) (IDNS), and will be less than the related recommendations for exposure to the general population or 100 mrem/yr. (e.g., NCRP Report 91 and IDNS regulations).

SOURCE MATERIAL - means uranium or thorium, or any combination of uranium or thorium in any physical or chemical form or ores which contain by weight 1/20 of one percent (0.05%) or more of uranium; thorium; or any combination of uranium and thorium.

Volatile Organic Compounds (e.g., ethylbenzene, xylene)

ETHYLBENZENE C_8H_{10}

CAS: 100-41-4 NIOSH: DA 0700000 DOT: 1175

OSHA PEL: 100 ppm STEL: 125 ppm IDLH: 2000 ppm

TOXIC AND HAZARD PROPERTIES:

Moderate irritation effects via irritation to the skin, eyes, mucus membranes, oral and inhalation routes. The liquid is an irritant to the skin and mucus membranes. Vapor is an irritant first tot he eyes, then causes dizziness, irritation of the nose and throat and a sense of chest constriction leading to congestion of the lungs, with edema. Liquid contact can cause erythema and inflammation of the skin. Dangerous fire hazard from heat, flame, powerful oxidizer.

PROPERTIES:

Colorless liquid, aromatic odor.

MW:	106.2	VP:	(79°F)
BP:	277°F	FRZ:	-139°F
SOL:	0.01%	UEL:	6.7%
FLP:	55°F	LEL:	1.0%
IP:	8.76 eV	SG:	0.87

XYLENE C_8H_{10}

TOXIC AND HAZARD PROPERTIES:

A human eye irritant; some transient corneal and conjunctival irritation effects noted. Absorbed via the skin. Dangerous fire hazard from heat, flame, powerful oxide.

PROPERTIES:

A clear liquid

MW:	106.2	VP:	9°F
BP:	281°F	FRZ:	56°F
SOL:	Insol	UEL:	7.0%
FLP:	81°F	LEL:	1.1%
IP:	8.44 eV	SG:	0.86

Ethylbenzene or Xylene First-Aid Treatment

If these chemicals contact the eyes, immediately wash with large amounts of water and continue flushing for 15 minutes, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

If these chemicals contact the skin, wash with soap and water.

If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.

If this chemical has been swallowed get medical attention immediately.

Polynuclear Aromatic Compounds (e.g., anthracene, fluoranthene, pyrene)

ANTHRACENE $C_{14}H_{10}$

CAS: 120-12-7
NIOSH: CA 9350000
skn-mus: 118 µg MLD
scu-rat TDLo: 3300 mg/kg/33W-I:NEO
orl-rat TDLo: 20 g/kg/79W-I:ETA

TOXIC AND HAZARD REVIEW:

An experimental tumorigen and neoplastigen. A skin irritant and allergen. Combustible when exposed to heat, flame, or oxidizing materials. Moderately explosive when exposed to flame; Ca $(OCl)_2$; chromic acid. To fight fire, use water, foam, CO_2, water spray or mist, dry chemical. Explodes on contact with fluorine.

PROPERTIES:

Colorless crystals, violet fluorescence.

MW:	178.24•°C	VP:	1 mm @ 145.0•°C
BP:	339.9°F	FRZ:	NA
SOL:	Insol in water	UEL:	NA
FLP:	NA	LEL:	0.6%
IP:	NA	SG:	1.24 @ 27•°/4•°C

FLUORANTHENE $C_{16}H_{10}$

CAS: 206-44-0 NIOSH: LL 4025000

skn-mus TDLo: 280 mg/kg/58 W-I:ETA

orl-rat LD50: 2000 mg/kg

TOXIC AND HAZARD REVIEW:

Poison by intravenous route. Moderately toxic by ingestion and skin contact. An experimental tumorigen. Human mutagenic data. combustible when exposed to heat or flame. When heated to decomposition, it emits acrid smoke and irritating fumes.

PROPERTIES:

A polycyclic hydrocarbon. Colorless solid.

MW:	202.26•°C	VP:	0.1 mm @ 20•°C
BP:	367°C	FRZ:	NA
SOL:	NA	UEL:	NA
FLP:	NA	LEL:	NA
IP:	NA	SG:	NA

PYRENE $C_{16}H_{10}$

CAS: 129-00-0 NIOSH: UR 2450000

skn-mus TDLo: 10 g/kg/3W-I:ETA

orl-rat LD50: 170 mg/m^3

TOXIC AND HAZARD REVIEW:

Poison by inhalation. Moderately toxic by ingestion and intraperitoneal routes. An experimental tumorigen. Human mutagenic data. A skin irritant. When heated to decomposition, it emits acrid smoke and irritating fumes.

PROPERTIES:

Colorless solid, solutions have a slight blue color.

MW:	202°C	VP:	NA
BP:	404°C	FRZ:	NA
SOL:	Insol in water	UEL:	NA
FLP:	NA	LEL:	NA
IP:	NA	SG:	1.271 @ 23°C

Heavy Petroleum Hydrocarbons

CRUDE OIL $\geq C_2H_6$; Generally C_8 and higher

CAS: 8002-05-9 NIOSH: SE 7175000

skn-mus TDLo: 3744 mg/kg/2Y-I:CAR

TOXIC AND HAZARD REVIEW:

An experimental carcinogen, neoplastigen and tumorigen by skin contact. A dangerous fire hazard when exposed to heat, flame, or powerful oxidizers. When heated to decomposition, it emits acrid smoke and irritating fumes.

PROPERTIES:

A thick flammable, dark yellow to brown or green-black liquid.

MW:	NA	VP:	NA
BP:	NA	FRZ:	NA
SOL:	Insol in water	UEL:	NA
FLP:	NA	LEL:	NA
IP:	NA	SG:	0.78-0.97

APPENDIX B.4

DEPARTMENT OF NUCLEAR SAFETY STANDARDS
FOR PROTECTION AGAINST RADIATION

TITLE 32: ENERGY
CHAPTER II:
DEPARTMENT OF NUCLEAR SAFETY
SUBCHAPTER b: RADIATION PROTECTION

PART 340
STANDARDS FOR PROTECTION AGAINST RADIATION

SUBPART A: GENERAL PROVISIONS

SUBPART B: RADIATION PROTECTION PROGRAMS

SUBPART C: OCCUPATIONAL DOSE LIMITS

SUBPART D: RADIATION DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC

SUBPART E: TESTING FOR LEAKAGE OR CONTAMINATION OF SEALED SOURCES

SUBPART F: SURVEYS AND MONITORING

SUBPART G: CONTROL OF EXPOSURE FROM EXTERNAL SOURCES IN RESTRICTED AREAS

SUBPART H: RESPIRATORY PROTECTION AND CONTROLS TO RESTRICT INTERNAL EXPOSURE IN RESTRICTED AREAS

SUBPART I: STORAGE AND CONTROL OF LICENSED OR REGISTERED SOURCES OF RADIATION

SUBPART J: PRECAUTIONARY PROCEDURES

SUBPART K: WASTE DISPOSAL

SUBPART L: RECORDS

SUBPART M: REPORTS AND NOTIFICATIONS

SUBPART N: ADDITIONAL REQUIREMENTS

AUTHORITY: Implementing and authorized by Section 16 of the Radiation Protection Act of 1990 (Ill. Rev. Stat. 1991, ch. 111½, par. 210-16) [420 ILCS 40/16].

SOURCE: Filed April 24, 1970 by the Department of Public Health; transferred to the Department of Nuclear Safety by P.A. 81-1516, effective December 3, 1980; amended at 5 Ill. Reg. 9586, effective September 10, 1981; codified at 7 Ill. Reg. 16027; Recodified at 10 Ill. Reg. 11273; amended at 10 Ill. Reg. 17538, effective September 25, 1986; amended at 16 Ill. Reg. 11538, effective July 7, 1992; old Part repealed, new Part adopted at 17 Ill. Reg. 18507, effective January 1, 1994.

SUBPART A: GENERAL PROVISIONS

Section 340.10 Purpose

a) This Part establishes standards for protection against ionizing radiation resulting from activities conducted pursuant to licenses or registrations issued by the Department. This Part is issued pursuant to the Radiation Protection Act of 1990 (Ill. Rev. Stat. 1991, ch. 111½, par. 210-1 et seq.) [420 ILCS 40].

b) The requirements of this Part are designed to control the receipt, possession, use, transfer, and disposal of sources of radiation by any licensee or registrant so that the total dose to an individual, including doses resulting from all sources of radiation other than background radiation, does not exceed the standards for protection against radiation prescribed in this Part. However, nothing in this Part shall be construed as limiting actions that may be necessary to protect health and safety in an emergency.

Section 340.20 Scope

Except as specifically provided in other regulations of the Department, this Part applies to persons licensed or registered by the Department to receive, possess, use, transfer or dispose of sources of radiation pursuant to 32 Ill. Adm. Code: Chapter II, Subchapters b and d. The limits in this Part do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of medical diagnosis or therapy, or to voluntary participation in medical research programs.

Section 340.25 Incorporations by Reference

All rules, standards and guidelines of agencies of the United States or nationally recognized organizations or associations that are incorporated by reference in this Part are incorporated as of the date specified in the reference and do not include any later amendments or editions. Copies of these rules, standards and guidelines that have been incorporated by reference are available for public inspection at the Department of Nuclear Safety, 1035 Outer Park Drive, Springfield, Illinois.

AGENCY NOTE: In this Part, the Department has incorporated by reference the appendices to 10 CFR 20, effective as of January 1, 1994. These appendices were originally published at 56 FR 23360 - 23474 (May 21, 1991). Corrections were published at 56 FR 61352 - 61353 (December 3, 1991) and an amendment was published at 57 FR 57877 - 57879 (December 8, 1992). The incorporation includes the 1991 correction and the 1992 amendment.

Section 340.30 Definitions

As used in this Part:

"Annual limit on intake" (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 0.05 Sv (5 rem) or a committed dose equivalent of 0.5 Sv (50 rem) to any individual organ or tissue. ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions.

"Class" (lung class or inhalation class) means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W or Y, which applies to a range of clearance half-times: for Class D(Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

"Derived air concentration" (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work would result in an intake of one ALI. For purposes of this definition, the condition of light work is an inhalation rate of 1.2 cubic meters of air per hour for 2,000 hours in a year. DAC values are given in Table 1, Column 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions.

"Derived air concentration-hour" (DAC-hour) means the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide (expressed in hours). A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 0.05 Sv (5 rem).

"Inhalation class" (see "Class").

"Lung class" (see "Class").

"Nonstochastic effect" (deterministic effect) means a health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect.

"Planned special exposure" means an infrequent exposure to radiation, the dose from which is separate from and in addition to the annual occupational dose limits.

"Reference Man" means a hypothetical aggregation of human physical and physiological characteristics determined by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

AGENCY NOTE: A description of the Reference Man is contained in the International Commission on Radiological Protection report, ICRP Publication 23, "Report of the Task Group on Reference Man."

"Respiratory protective equipment" means an apparatus, such as a respirator, used to reduce an individual's intake of airborne radioactive materials.

"Sanitary sewerage" means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

"Stochastic effect" (probabilistic effect) means a health effect that occurs randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

"Weighting factor" (w[T]), means the proportion of the risk of stochastic effects resulting from irradiation of an organ or tissue (T) to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w[T] are:

Organ or Tissue	w[T]
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30[a]
Whole Body	1.00[b]

[a] 0.30 results from 0.06 for each of 5 "remainder" organs, excluding the skin and the lens of the eye, that receive the highest doses.

[b] For the purpose of weighting the external whole-body dose, for adding it to the internal dose, a single weighting factor, w[T] = 1.0, has been specified.

Section 340.40 Implementation

a) Any existing license condition that is more restrictive than this Part remains in force until there is an amendment or renewal of the license.

b) If a license condition exempts a licensee from a provision of this Part in effect before January 1, 1994, it also exempts the licensee from the corresponding provision of this Part, as revised effective January 1, 1994, until there is an amendment or renewal of the license that modifies or removes the condition.

c) If a license condition cites provisions of this Part in effect before January 1, 1994, which do not correspond to any provisions of this Part, as revised effective January 1, 1994, the license condition remains in force until there is an amendment or renewal of the license that modifies or removes the condition.

SUBPART B: RADIATION PROTECTION PROGRAMS

Section 340.110 Radiation Protection Programs

a) Each licensee or registrant shall develop, document and implement a radiation protection

program that ensures compliance with the provisions of this Part. (See Section 340.1120 for recordkeeping requirements relating to these programs.)

b) The licensee or registrant shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and public doses that are as low as is reasonably achievable (ALARA).

c) The licensee shall review, at intervals not to exceed 12 months, the radiation protection program content and implementation.

d) The registrant shall review, at intervals not to exceed 1 inspection cycle as specified in 32 Ill. Adm. Code 410.60(d), the radiation protection program content and implementation.

SUBPART C: OCCUPATIONAL DOSE LIMITS

Section 340.210 Occupational Dose Limits for Adults

a) The licensee or registrant shall control the occupational dose to individual adults, except for planned special exposures pursuant to Section 340.260, to the following dose limits:

1) An annual limit, which is the more limiting of:

A) The total effective dose equivalent being equal to 0.05 Sv (5 rem); or

B) The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv (50 rem).

2) The annual limits to the lens of the eye, to the skin and to the extremities which are:

A) An eye dose equivalent of 0.15 Sv (15 rem), and

B) A shallow dose equivalent of 0.5 Sv (50 rem) to the skin or to any extremity.

b) Doses received in excess of the annual limits, including doses received during accidents, emergencies and planned special exposures, shall be subtracted from the limits for planned special exposures that the individual may receive during the current year and during the individual's lifetime (see Section 340.260(e)).

c) The assigned deep dose equivalent and shallow dose equivalent shall be for the portion of the body receiving the highest exposure.

d) The deep dose equivalent, eye dose equivalent and shallow dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

e) Derived air concentration (DAC) and annual limit on intake (ALI) values are specified in Table 1 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, and may be used to determine the individual's dose (see Section 340.1160) and to demonstrate compliance with the occupational dose limits.

f) Notwithstanding the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions.)

g) The licensee or registrant shall reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person during the current year (see Section 340.250(a) and (d)).

AGENCY NOTE: The purpose of this requirement is to ensure that no individual receives an annual occupational dose in excess of the occupational dose limits set forth in this Section.

Section 340.220 Compliance with Requirements for Summation of External and Internal Doses

a) General Requirement. If the licensee is required to monitor individual occupational dose pursuant to both Section 340.520(a) and (b), the licensee shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor individual occupational dose only pursuant to Section 340.520(a) or only pursuant to Section 340.520(b), then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses pursuant to subsections (b), (c) and (d) below. The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

b) Intake by Inhalation. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

1) The sum of the fractions of the inhalation ALI for each radionuclide; or

2) The total number of derived air concentration-hours (DAC-hours) for all

radionuclides divided by 2,000; or

3) The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factor(w[T]) and the committed dose equivalent, H[T,50], per unit intake is greater than ten percent of the maximum weighted value of H[T,50] (i.e., w[T]H[T,50]) per unit intake for any organ or tissue.

c) Intake by Oral Ingestion. If the occupationally exposed individual receives an intake of radionuclides by oral ingestion greater than ten percent of the applicable oral ALI, the licensee shall account for this intake and include it in demonstrating compliance with the limits.

d) Intake Through Wounds or Absorption Through Skin. The licensee shall evaluate and, to the extent practicable, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be further evaluated or accounted for pursuant to this subsection.

Section 340.230 Determination of External Dose from Airborne Radioactive Material

a) Licensees shall, when determining the dose from airborne radioactive material, include the contribution to the deep dose equivalent, eye dose equivalent and shallow dose equivalent from external exposure to the radioactive cloud (see footnotes 1 and 2 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions).

b) Airborne radioactivity measurements and DAC values shall not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep dose equivalent to an individual shall be based upon measurements using instruments or individual monitoring devices.

Section 340.240 Determination of Internal Exposure

a) For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee shall, when required pursuant to Section 340.520, take measurements of:

1) Concentrations of radioactive materials in air in work areas during conditions of operations; or

2) Quantities of radionuclides in the body after exposure to materials that could result in an intake; or

3) Quantities of radionuclides excreted from the body after exposure to materials that could result in an intake; or

4) Combinations of these measurements.

b) Unless respiratory protective equipment is used, as provided in Section 340.730, or the assessment of intake is based on bioassays, the licensee shall assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

c) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in an individual is known, the licensee may:

1) Use that information to calculate the committed effective dose equivalent, and if used, the licensee shall document that information in the individual's record; and

2) Upon prior approval of the Department, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material (e.g., aerosol size distribution or density); and

3) Separately assess the contribution of fractional intakes of Class D, W or Y compounds of a given radionuclide (see Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, to the committed effective dose equivalent).

d) If the licensee chooses to assess intakes of Class Y material using the measurements specified in subsections (a)(2) or (3) above, the licensee may delay the recording and reporting of the assessments for periods up to 7 months, unless otherwise required by Sections 340.1220 or 340.1230.

AGENCY NOTE: This delay permits the licensee to make additional measurements basic to the assessments.

e) If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours shall be either:

1) The sum of the ratios of the concentration to the appropriate DAC value (e.g., D, W or Y) from Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, for each radionuclide in the mixture; or

2) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in

the mixture.

f) If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.

g) When a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

1) The licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in Section 340.210 and in complying with the monitoring requirements in Section 340.520(b);

2) The concentration of any radionuclide disregarded is less than ten percent of its DAC; and

3) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

h) When determining the committed effective dose equivalent, the following information may be considered:

1) In order to calculate the committed effective dose equivalent, the licensee may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 0.05 Sv (5 rem) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

2) For an ALI (and the associated DAC) determined by the nonstochastic organ dose limit of 0.5 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem) (the stochastic ALI) is listed in parentheses in Table 1 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions. The licensee may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALI the licensee shall also demonstrate that the limit in Section 340.210(a)(1)(B) is met.

Section 340.250 Determination of Prior Occupational Dose

a) For each individual who may enter the licensee's or registrant's restricted area and is likely to receive, in a year, an occupational dose requiring monitoring pursuant to Section 340.520, the licensee or registrant shall determine the occupational radiation dose received during the current year prior to allowing such individual to enter a restricted area. In order to comply with this requirement, a licensee or registrant may accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employers for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual may have received during the current year. To accomplish this, a licensee or registrant may use the Illinois Department of Nuclear Safety (IDNS) Form 5.

AGENCY NOTE: Licensees and registrants also should attempt to obtain the records of cumulative occupational radiation dose.

b) Prior to permitting an individual to participate in a planned special exposure, the licensee shall:

1) Determine the cumulative occupational radiation dose.

A) In order to comply with this requirement, a licensee may accept, as the record of cumulative radiation dose, an up-to-date IDNS Form 4, or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employers (if the individual is not employed by the licensee); and

B) Obtain reports of the individual's dose equivalent for the time period subsequent to that included in IDNS Form 4, or equivalent, as specified in subsection (1)(A) above. Such reports shall be signed by the individual and countersigned by an appropriate official(s) of the most recent employer(s) for work involving radiation exposure, or the individual's current employer(s) (if the individual is not employed by the licensee). The information shall be recorded on IDNS Form 5, or equivalent.

2) Determine the internal and external doses from all previous planned special exposures.

3) Determine all doses in excess of the limits received during the lifetime of the individual, including doses received during accidents and emergencies.

c) The licensee or registrant shall record the exposure history, as required by subsections (a) and (b) above, on IDNS Form 4 or 5, as applicable, or other clear and legible record containing all of the information required on that form.

1) The form or record shall show each period in which the individual received occupational exposure to sources of radiation and shall be signed by the individual who received the

exposure. For each period for which the licensee or registrant obtains reports, the licensee or registrant shall use the dose shown in the report in preparing the exposure history. For any period in which the licensee or registrant does not obtain a report, the licensee or registrant shall place a notation on the exposure history indicating the periods of time for which data are not available.

2) For the purpose of complying with this requirement, licensees or registrants are not required to reevaluate the separate external dose equivalents and internal committed dose equivalents or intakes of radionuclides assessed before January 1, 1994. Further, although occupational exposure histories obtained and recorded before January 1, 1994, would not have included effective dose equivalent, such histories may be used in the absence of specific information on the intake of radionuclides by the individual.

d) If the licensee or registrant is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee or registrant:

1) When establishing administrative controls pursuant to Section 340.210(g) for the current year, shall assume that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each calendar quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

2) Shall not authorize the individual to receive any planned special exposures.

e) Records shall be retained in accordance with the requirements of Section 340.1140(a).

Section 340.260 Planned Special Exposures

A licensee may authorize an adult worker to receive doses in addition to, and accounted for separately from, the doses received under the limits specified in Section 340.210 provided that each of the following conditions are satisfied:

a) The licensee authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the higher exposure are unavailable or impractical.

AGENCY NOTE: An example of an exceptional situation is the retrieval of an industrial radiography source from an area that cannot be evacuated.

b) The management official of the licensee and employer, if the employer is not the licensee, specifically authorize the planned special exposure, in writing, before the exposure occurs.

c) Before a planned special exposure, the licensee ensures that each individual involved is:

1) Informed of the purpose of the planned operation; and

2) Informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and

3) Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

d) Prior to permitting an individual to participate in a planned special exposure, the licensee ascertains previous doses received during the lifetime of the individual as required by Section 340.250(b).

e) Subject to Section 340.210(b), the licensee shall not authorize a planned special exposure that would cause an individual's dose from all planned special exposures and all doses in excess of the limits to exceed:

1) The numerical values of any of the dose limits in Section 340.210(a) in any year; and

2) Five times the annual dose limits in Section 340.210(a) during the individual's lifetime.

f) The licensee maintains records of the conduct of a planned special exposure in accordance with Section 340.1150 and submits a written report in accordance with Section 340.1240.

g) The licensee records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposure need not be considered in controlling future occupational dose of the individual pursuant to Section 340.210(a) but shall be included in evaluations required by subsections (d) and (e) above.

Section 340.270 Occupational Dose Limits for Minors

The annual occupational dose limits for minors are ten percent of the annual occupational dose limits specified for adult workers in Section 340.210.

Section 340.280 Dose to an Embryo/Fetus

a) Except as otherwise provided in subsections (d) and (e) below, the licensee or registrant shall ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 5 mSv (0.5 rem). (For recordkeeping requirements, see Section 340.1160(d).)

b) The dose to an embryo/fetus shall be taken as the sum of:

1) The deep dose equivalent to the declared

pregnant woman during the entire pregnancy; and

2) The dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman during the entire pregnancy.

c) The licensee or registrant shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in subsection (a) above.

AGENCY NOTE: The National Council on Radiation Protection and Measurements report entitled "Recommendations on Limits for Exposure to Ionizing Radiation," NCRP 91, published June 1, 1987, recommends that no more than 0.5 mSv (0.05 rem) of the allowed dose to the embryo/fetus be received during any one month during a declared pregnancy.

d) If the declared pregnant woman has not notified the licensee or registrant of the estimated date of conception, the licensee or registrant shall ensure that the dose to an embryo/fetus, as specified in subsection (b) above, due to occupational exposure of the declared pregnant woman does not exceed 0.5 mSv (0.05 rem) per month, during the remainder of the pregnancy. If after initially declaring her pregnancy, a declared pregnant woman advises the licensee or registrant of the estimated date of conception, the dose limits specified in subsections (a) and (e) of this Section shall apply.

AGENCY NOTE: The Department encourages licensees and registrants to explain to declared pregnant workers that providing an estimated date of conception will enable the licensee or registrant to more accurately assess the radiation dose to the embryo/fetus and assist the licensee or registrant in determining appropriate precautions to be taken for the remainder of the pregnancy.

e) If by the time the woman informs the licensee or registrant of the estimated date of conception the dose to the embryo/fetus has exceeded 4.5 mSv (0.45 rem), the licensee or registrant shall be deemed to be in compliance with subsection (a) above if the additional dose to the embryo/fetus as specified in subsection (b) above does not exceed 0.5 mSv (0.05 rem) during the remainder of the pregnancy.

SUBPART D: RADIATION DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC

Section 340.310 Dose Limits for Individual Members of the Public

a) Each licensee or registrant shall conduct operations so that:

1) The dose in any unrestricted area from external sources does not exceed 0.02 mSv(0.002 rem) in any one hour; and

2) The total effective dose equivalent to individual members of the public from the licensed or registered operation, exclusive of the dose contribution from the licensee's disposal of radioactive material into sanitary sewerage in accordance with Section 340.1030, does not exceed:

A) 5 mSv (0.5 rem) in any year at locations within facilities where sources of radiation were installed before January 1, 1994, and the use of the source of radiation does not change on or after January 1, 1994; or

B) 1 mSv (0.1 rem) in any year at locations within facilities where sources of radiation are installed or where the source of radiation or its use changes on or after January 1, 1994.

AGENCY NOTE: It is the Department's intent to allow facilities designed to the 5 mSv (0.5 rem) limit to continue to use the 5 mSv (0.5 rem) total effective dose equivalent limit for a member of the public. This includes locations where the intensity of a source of radiation is not increased beyond the design basis, the type of radiation use is not changed, and the type of facility use is not changed.

b) A registrant, a licensee or an applicant for a license may apply for prior Department authorization to operate up to an annual dose limit for an individual member of the public of 5 mSv (0.5 rem). This application shall include the following information:

1) Demonstration of the need for and the expected duration of operations in excess of the limit in subsection (a)(2)(B) above;

2) The licensee's or registrant's program to assess and control dose within the 5 mSv (0.5 rem) annual limit; and

3) The procedures to be followed to maintain the dose ALARA.

c) Prior to allowing a member of the public to enter a restricted area, the licensee or registrant shall give instructions on radiation hazards and protective measures to that individual.

Section 340.320 Compliance with Dose Limits for Individual Members of the Public

a) The licensee or registrant shall make or cause to be made surveys of radiation levels in unrestricted areas. In addition, licensees shall survey radioactive materials in effluents released to unrestricted areas. These surveys are to demonstrate compliance with the dose limits for

individual members of the public in Section 340.310.

b) A licensee or registrant shall show compliance with the annual dose limit in Section 340.310 by:

1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed or registered operation does not exceed the annual dose limit; or

2) Demonstrating that:

A) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions; and

B) If an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv (0.002 rem) in an hour and 0.5 mSv (0.05 rem) in a year.

c) Upon approval from the Department, the licensee may adjust the effluent concentration values in Table 2 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, for members of the public, to take into account the actual physical and chemical characteristics of the effluents (e.g., aerosol size distribution, solubility, density, radioactive decay equilibrium and chemical form).

SUBPART E: TESTING FOR LEAKAGE OR CONTAMINATION OF SEALED SOURCES

Section 340.410 Testing for Leakage or Contamination of Sealed Sources

a) The licensee in possession of any sealed source shall assure that:

1) Each sealed source, except as specified in subsection (b) below, is tested for leakage or contamination and the test results are received before the sealed source is put into use unless the licensee has a certificate from the transferor indicating that the sealed source was tested within 6 months before transfer to the licensee.

2) Each sealed source that is not designed to emit alpha particles is tested for leakage or contamination at intervals not to exceed 6 months or at alternative intervals approved by the Department, pursuant to 32 Ill. Adm. Code 330.280(m), an Agreement State, a Licensing State or the U.S. Nuclear Regulatory Commission.

3) Each sealed source that is designed to emit alpha particles is tested for leakage or contamination at intervals not to exceed 3 months or at alternative intervals approved by the Department, pursuant to 32 Ill. Adm. Code 330.280(m), an Agreement State, a Licensing State or the Nuclear Regulatory Commission.

4) For each sealed source that is required to be tested for leakage or contamination, at any other time there is reason to suspect that the sealed source might have been damaged or might be leaking, the licensee shall assure that the sealed source is tested for leakage or contamination before further use.

5) Tests for leakage for all sealed sources, except brachytherapy sources manufactured to contain radium, shall be capable of detecting the presence of 185 Bq (0.005 uCi) of radioactive material on a test sample. Test samples shall be taken from the sealed source or from the surfaces of the container in which the sealed source is stored or mounted on which one might expect contamination to accumulate. For a sealed source contained in a device, test samples are obtained when the source is in the "off" position. If setting the source to the "off" position would disrupt the licensee's activities, test samples may be obtained while the source is in the "on" position, provided that the dose likely to be received by the individual while obtaining the samples will not be so great as to require monitoring pursuant to Section 340.520(a).

6) The test for leakage for brachytherapy sources manufactured to contain radium shall be capable of detecting an absolute leakage rate of 37 Bq (0.001 uCi) of radon-222 in a 24 hour period when the collection efficiency for radon-222 and its daughters has been determined with respect to collection method, volume and time.

7) Tests for contamination from radium daughters shall be taken on the interior surface of brachytherapy source storage containers and shall be capable of detecting the presence of 185 Bq (0.005 uCi) of a radium daughter which has a half-life greater than 4 days.

b) A licensee need not perform tests for leakage or contamination on the following sealed sources:

1) Sealed sources containing only radioactive material with a half-life of less than 30 days;

2) Sealed sources containing only radioactive material as a gas;

3) Sealed sources containing 3.7 MBq (100 uCi) or less of beta or photon-emitting material or

370 kBq (10 uCi) or less of alpha-emitting material;

4) Sealed sources containing only hydrogen-3;

5) Seeds of iridium-192 encased in nylon ribbon;

6) Sealed sources, except teletherapy and brachytherapy sources, which are stored, not being used and identified as in storage. The licensee shall, however, test each such sealed source for leakage or contamination and receive the test results before any use or transfer unless it has been tested for leakage or contamination within 6 months before the date of use or transfer; and

7) Sealed sources distributed under a license issued pursuant to 32 Ill. Adm. Code 330.280(m), but only if the evaluation sheet for those sealed sources, as filed in the "Radioactive Material Reference Manual" maintained by the Department of Health and Human Services or in the "Registry of Radioactive Sealed Sources and Devices" maintained by the U.S. Nuclear Regulatory Commission, specifies that testing for leakage or contamination is not required.

c) Tests for leakage or contamination from sealed sources shall be performed by persons specifically authorized by the Department, an Agreement State, a Licensing State or the Nuclear Regulatory Commission to perform such services.

d) Test results shall be kept in units of becquerel or microcurie and maintained for inspection by the Department.

e) The following shall be considered evidence that a sealed source is leaking:

1) The presence of 185 Bq (0.005 uCi) or more of removable contamination on any test sample.

2) Leakage of 37 Bq (0.001 uCi) of radon-222 per 24 hours for brachytherapy sources manufactured to contain radium.

3) The presence of removable contamination resulting from the decay of 185 Bq (0.005 uCi) or more of radium.

f) The licensee shall immediately withdraw a leaking sealed source from use and shall take action to prevent the spread of contamination. The leaking sealed source shall be repaired or disposed of in accordance with this Part.

g) Reports of test results for leaking or contaminated sealed sources shall be made pursuant to Section 340.1260.

SUBPART F: SURVEYS AND MONITORING

Section 340.510 General

a) Each licensee or registrant shall make, or cause to be made, surveys:

1) That demonstrate compliance with this Part; and

2) That evaluate:

A) The extent of radiation levels;

B) Concentrations or quantities of radioactive material; and

C) The potential radiological hazards that could be present.

b) The licensee or registrant shall ensure that instruments and equipment used for quantitative radiation measurements (e.g., dose rate and effluent monitoring) are calibrated at intervals not to exceed 12 months for the radiation measured or at alternative intervals specified in regulations of the Department, an Agreement State, a Licensing State or the Nuclear Regulatory Commission.

c) Personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremity, that require processing to determine the radiation dose and that are used by licensees or registrants to comply with Section 340.210, with other applicable provisions of 32 Ill. Adm. Code: Chapter II, Subchapters b and d, or with conditions specified in a license shall be processed and evaluated by a qualified dosimetry processor. A dosimetry processor is qualified if:

1) It holds current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

2) It is approved by NVLAP for the type of radiation or radiations that most closely approximate the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

d) The licensee or registrant shall ensure that adequate precautions are taken to prevent deceptive exposure of an individual monitoring device.

Section 340.520 Conditions Requiring Individual Monitoring of External and Internal Occupational Dose

Each licensee or registrant shall monitor doses from sources of radiation at levels sufficient to demonstrate compliance with the occupational dose limits of this Part. As a minimum:

a) Each licensee or registrant shall monitor occupational dose from sources of radiation and shall supply and require the use of individual monitoring devices by:

1) Adults likely to receive, in 1 year from sources external to the body, a dose in excess of ten percent of the limits in Section 340.210(a);

2) Minors and declared pregnant women likely to receive, in 1 year from sources external to the body, a dose in excess of ten percent of any of the applicable limits in Sections 340.270 or 340.280; and

3) Individuals entering a high or very high radiation area.

b) Each licensee shall monitor, to determine compliance with Section 340.240, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

1) Adults likely to receive, in 1 year, an intake in excess of ten percent of the applicable ALIs in Table 1, Columns 1 and 2 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions; and

2) Minors and declared pregnant women likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.5 mSv (0.05 rem).

Section 340.530 Location of Individual Monitoring Devices

Each licensee or registrant shall ensure that individuals who are required to monitor occupational doses in accordance with Section 340.520(a) wear individual monitoring devices as follows:

a) An individual monitoring device used for monitoring the dose to the whole body shall be worn at the unshielded location of the whole body likely to receive the highest exposure. When a protective apron is worn, the location of the individual monitoring device is typically at the neck (collar).

b) An individual monitoring device used for monitoring the dose to an embryo/fetus of a declared pregnant woman, pursuant to Section 340.280(a), shall be located at the waist under any protective apron being worn by the woman.

c) An individual monitoring device used for monitoring the eye dose equivalent, to demonstrate compliance with Section 340.210(a)(2)(A), shall be located at the neck (collar), outside any protective apron being worn by the monitored individual, or at an unshielded location closer to the eye.

d) An individual monitoring device used for monitoring the dose to the extremities, to demonstrate compliance with Section 340.210(a)(2)(B), shall be worn on the extremity likely to receive the highest exposure. Each individual monitoring device shall be oriented to measure the highest dose to the extremity being monitored.

SUBPART G: CONTROL OF EXPOSURE FROM EXTERNAL SOURCES IN RESTRICTED AREAS

Section 340.610 Control of Access to High Radiation Areas

a) The licensee shall ensure that each entrance or access point to a high radiation area has one or more of the following features:

1) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep dose equivalent of 1 mSv (0.1 rem) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates; or

2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

3) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

b) In place of the controls required by subsection (a) above for a high radiation area, the licensee may substitute continuous direct or electronic surveillance to enable action to be taken to prevent unauthorized entry.

c) The licensee may apply to the Department for approval of alternative methods for controlling access to high radiation areas.

d) The licensee shall establish the controls required by subsections (a) and (c) above in a way that does not prevent individuals from leaving a high radiation area.

e) The licensee is not required to control each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation provided that:

1) The packages do not remain in the area longer than 3 days; and

2) The dose rate at 1 meter from the external surface of any package does not exceed 0.1 mSv (0.01 rem) per hour.

f) The licensee is not required to control entrance or access to rooms or other areas in hospitals solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who are taking the necessary precautions, as required by 32 Ill. Adm. Code 335, to prevent the exposure of individuals to radiation or radioactive material in excess of the limits established in this Part and to operate within the ALARA provisions of the licensee's radiation protection program.

g) The registrant shall control entrance or access to rooms or other areas containing sources of radiation capable of producing a high radiation area as described in this Section in accordance with the requirements for access and control specified in other applicable Parts of 32 Ill. Adm. Code: Chapter II, Subchapters b and d (i.e., 32 Ill. Adm. Code 350 for industrial radiography, 32 Ill. Adm. Code 360 for use of x-rays in the healing arts and 32 Ill. Adm. Code 390 for particle accelerators).

Section 340.620 Control of Access to Very High Radiation Areas

In addition to the controls required by Section 340.610, the licensee or registrant shall institute measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 5 Gy (500 rad) or more in 1 hour at 1 meter from a source of radiation or any surface through which the radiation penetrates.

Section 340.630 Control of Access to Very High Radiation Areas - Irradiators

a) This Section applies to licensees or registrants with sources of radiation in irradiators that are not self-shielded. This Section does not apply to sources of radiation that are used in teletherapy, in industrial radiography or in completely self-shielded irradiators in which the source is both stored and operated within the same radiation shielding barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create a radiation level of 5 Gy (500 rad) or more in 1 hour at 1 meter in an area that is accessible to any individual.

b) Each area in which there may exist radiation levels in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a source of radiation that is used to irradiate matter shall meet the following requirements:

1) Each entrance or access point shall be equipped with entry control devices that:

A) Function automatically to prevent any individual from inadvertently entering a very high radiation area;

B) Permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the source of radiation, to be reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

C) Prevent operation of the source of radiation if it would produce radiation levels in the area that could result in a deep dose equivalent to an individual in excess of 1 mSv (0.1 rem) in 1 hour.

2) Additional control devices shall be provided so that, upon failure of the entry control devices to function as required by subsection (b)(1) above:

A) The radiation level within the area, from the source of radiation, is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

B) Conspicuous visible and audible alarm signals are generated to make an individual attempting to enter the area aware of the hazard. The alarm signals shall be located so that at least one other authorized individual, who is physically present, familiar with the activity, and prepared to render or summon assistance, is made aware of the failure of the entry control devices.

3) The licensee or registrant shall provide control devices so that, upon failure or removal of any physical radiation barriers, other than the shielded storage container for sealed sources:

A) The radiation level from the source of radiation is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

B) Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or registrant or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.

4) When the shield for the stored sealed source is a liquid, the licensee shall provide means to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding.

5) Physical radiation barriers that comprise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of subsections (b)(3) and (4) above.

6) Each area shall be equipped with devices that will automatically generate conspicuous visible and audible alarm signals to alert personnel in the area before the source of radiation can be put into operation and in time for any individual in the area to operate a clearly identified control device, which must be installed in the area and which can prevent

the source of radiation from being put into operation.

7) Each area shall be controlled by use of devices and administrative procedures that ensure that the area is cleared of personnel prior to each use of the source of radiation.

8) Each area shall be checked by a radiation measurement to ensure that, prior to the first individual's entry into the area after any use of the source of radiation, the radiation level from the source of radiation in the area is below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour.

9) The entry control devices required in subsection (b)(1) above shall be tested for proper functioning (see Section 340.1190 for recordkeeping requirements).

   A) Testing shall be conducted prior to initial operation with the source of radiation on any day, unless operations were continued uninterrupted from the previous day;

   B) Testing shall be conducted prior to resumption of operation of the source of radiation after any unintentional interruption; and

   C) The licensee or registrant shall submit and adhere to a schedule for periodic tests of the entry control and warning systems.

10) The licensee or registrant shall not conduct operations, other than those necessary to place the source of radiation in safe condition or to effect repairs on controls, unless control devices are functioning properly.

11) Entry and exit portals that are used in transporting matter to and from the irradiation area, and that are not intended for use by individuals, shall be controlled by such devices and administrative procedures as are necessary to physically protect and warn against inadvertent entry by any individual through these portals. Exit portals for irradiated matter shall be equipped to detect and signal the presence of any loose sealed sources that are carried toward such an exit and to automatically prevent loose sealed sources from being carried out of the area.

c) Registrants, licensees or applicants for licenses for sources of radiation that are within the purview of subsection (b) above and which will be used in a variety of positions or in locations (e.g., open fields or forests) that make it impracticable to comply with certain requirements of subsection (b) above, such as those for the automatic control of radiation levels, may apply to the Department for approval of alternative safety measures. Alternative safety measures shall provide personnel protection at least equivalent to those specified in subsection (b) above. At least one of the alternative measures shall include an entry-preventing interlock control based on a measurement of the radiation that ensures the absence of high radiation levels before an individual can gain access to the area where such sources of radiation are used.

d) The entry control devices required by subsections (b) and (c) above shall be established in such a way that no individual will be prevented from leaving the area.

SUBPART H: RESPIRATORY PROTECTION AND CONTROLS TO RESTRICT INTERNAL EXPOSURE IN RESTRICTED AREAS

Section 340.710 Use of Process or Other Engineering Controls

The licensee shall use, to the extent practicable, process or other engineering controls (e.g., containment or ventilation) to control the concentrations of radioactive material in air.

Section 340.720 Use of Other Controls

When it is not practicable to apply process or other engineering controls to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the licensee shall, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

a) Control of access; or

b) Limitation of exposure times; or

c) Use of respiratory protection equipment; or

d) Other controls.

Section 340.730 Use of Individual Respiratory Protection Equipment

a) If the licensee uses respiratory protection equipment to limit intakes pursuant to Section 340.720:

   1) Except as provided in subsection (a)(2) below, the licensee shall use only respiratory protection equipment that is tested and certified or had certification extended by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration (NIOSH/MSHA).

   2) The licensee may use equipment that has not been tested or certified by NIOSH/MSHA, has not had certification extended by NIOSH/MSHA, or for which there is no schedule for testing or certification, provided the licensee has submitted to the Department and the Department has approved an

application for authorized use of that equipment, including a demonstration by testing, or a demonstration on the basis of test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.

3) The licensee shall implement and maintain a respiratory protection program that includes:

A) Air sampling to identify the potential hazard, permit proper equipment selection, and estimate exposures;

B) Surveys and bioassays to evaluate actual intakes;

C) Testing of respirators for operability immediately prior to each use;

D) Written procedures regarding selection, fitting, issuance, maintenance and testing of respirators, including testing for operability immediately prior to each use; supervision and training of personnel; monitoring, including air sampling and bioassays; and recordkeeping; and

E) Determination by a physician prior to initial fitting of respirators, and at least every 12 months thereafter, that the individual user is physically able to use the respiratory protection equipment.

4) The licensee shall issue a written policy statement on respirator usage covering:

A) The use of process or other engineering controls, instead of respirators;

B) The routine, nonroutine and emergency use of respirators; and

C) The length of periods of respirator use and relief from respirator use.

5) The licensee shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions or any other conditions that might require such relief.

6) The licensee shall use respiratory protection equipment within the equipment manufacturer's expressed limitations for type and mode of use and shall provide proper visual, communication and other special capabilities (e.g., adequate skin protection) when needed.

b) When estimating exposure of individuals to airborne radioactive materials, the licensee may make allowance for respiratory protection equipment used to limit intakes pursuant to Section 340.720, provided that the following conditions, in addition to those in subsection (a) above, are satisfied:

1) The licensee selects respiratory protection equipment that provides a protection factor, specified in Appendix A to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, greater than the multiple by which peak concentrations of airborne radioactive materials in the working area are expected to exceed the values specified in Table 1, Column 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions. However, if the selection of respiratory protection equipment with a protection factor greater than the peak concentration is inconsistent with the goal specified in Section 340.720 of keeping the total effective dose equivalent ALARA, the licensee may select respiratory protection equipment with a lower protection factor provided that such a selection would result in a total effective dose equivalent that is ALARA. The concentration of radioactive material in the air that is inhaled when respirators are worn may be initially estimated by dividing the average concentration in air, during each period of uninterrupted use, by the protection factor. If the exposure is later found to be greater than initially estimated, the corrected value shall be used; if the exposure is later found to be less than initially estimated, the corrected value may be used.

2) The licensee shall obtain authorization from the Department before assigning respiratory protection factors in excess of those specified in Appendix A to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions. The Department shall authorize a licensee to use higher protection factors on receipt of an application that:

A) Demonstrates that a need exists for higher protection factors; and

B) Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

c) The licensee shall use as emergency equipment only respiratory protection equipment that has been specifically certified or had certification extended for emergency use by NIOSH/MSHA.

d) The licensee shall notify the Department, in writing, at least 30 days before the date that respiratory protection equipment is first used

pursuant to the provisions of either subsection (a) or (b) above.

SUBPART I: STORAGE AND CONTROL OF LICENSED OR REGISTERED SOURCES OF RADIATION

Section 340.810 Security and Control of Licensed or Registered Sources of Radiation

a) The licensee shall secure licensed radioactive material from unauthorized removal or access.

b) The licensee shall maintain constant surveillance, and use devices or administrative procedures to prevent unauthorized use of licensed radioactive material that is in an unrestricted area and that is not in storage.

c) The registrant shall secure registered radiation machines from unauthorized removal.

d) The registrant shall use devices or administrative procedures to prevent unauthorized use of registered radiation machines.

SUBPART J: PRECAUTIONARY PROCEDURES

Section 340.910 Caution Signs

a) Standard Radiation Symbol. Unless otherwise authorized by the Department, the symbol prescribed by this Part shall use the colors magenta, or purple, or black on yellow background. The symbol prescribed by this Part is the three-bladed design as shown in Section 340.Illustration A.

b) Exception to Color Requirements for Standard Radiation Symbol. Notwithstanding the requirements of subsection (a) above, licensees or registrants are authorized to label sources, source holders, or device components containing sources of radiation that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

c) Additional Information on Signs and Labels. In addition to the contents of signs and labels prescribed in this Part, the licensee or registrant may provide, on or near the required signs and labels, information to make individuals aware of potential radiation exposures and to minimize the exposures.

Section 340.920 Posting Requirements

a) Posting of Radiation Areas. The licensee or registrant shall post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA".

b) Posting of High Radiation Areas. The licensee or registrant shall post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA".

c) Posting of Very High Radiation Areas. The licensee or registrant shall post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA".

d) Posting of Airborne Radioactivity Areas. The licensee shall post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA".

e) Posting of Areas or Rooms in Which Licensed Ma terial is Used or Stored. The licensee shall post each area or room in which there is used or stored an amount of licensed material exceeding ten times the quantity of such material specified in Appendix C to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)".

Section 340.930 Exceptions to Posting Requirements

a) A licensee or registrant is not required to post caution signs in areas or rooms containing sources of radiation for periods of less than 8 hours, if each of the following conditions is met:

1) The sources of radiation are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to sources of radiation in excess of the limits established in this Part; and

2) The area or room is subject to the licensee's or registrant's control.

b) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs pursuant to Section 340.920 provided that the requirements of 32 Ill. Adm. Code 335.5030(a)(4) or 335.7030(b) are met.

c) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs, provided that:

1) A patient being treated with a permanent implant could be released from confinement pursuant to 32 Ill. Adm. Code 335.2110; or

2) A patient being treated with a therapeutic radiopharmaceutical could be released from confinement pursuant to 32 Ill. Adm. Code 335.5030(b).

d) A room or area is not required to be posted with a

caution sign because of the presence of a sealed source provided the radiation level at 30 centimeters (12 inches) from the surface of the sealed source container or housing does not exceed 0.05 mSv (0.005 rem) per hour.

e) A room or area is not required to be posted with a caution sign because of the presence of radiation machines used solely for diagnosis in the healing arts.

Section 340.940 Labeling Containers and Radiation Machines

a) The licensee shall ensure that each container of licensed material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL". The label shall also provide information (such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials and mass enrichment) to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

b) Each licensee shall, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

c) Each registrant shall ensure that each radiation machine is labeled in a manner that cautions individuals that radiation is produced when it is energized.

Section 340.950 Exemptions to Labeling Requirements

A licensee is not required to label:

a) Containers holding licensed material in quantities less than the quantities listed in Appendix C to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions; or

b) Containers holding licensed material in concentrations less than those specified in Table 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions; or

c) Containers attended by an individual who takes the precautions (e.g., controlling access) necessary to prevent the exposure of individuals in excess of the limits established by this Part; or

d) Containers when they are in transport, provided the containers are packaged and labeled in accordance with the regulations of the U.S. Department of Transportation; or

AGENCY NOTE: Labeling of packages containing radioactive materials is required by the U.S. Department of Transportation if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by 49 CFR 173.403(m) and (w) and 173.421 through 173.424, current as October 1, 1991, exclusive of subsequent amendments or editions.

e) Containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record (examples of containers of this type are containers in locations such as water-filled canals, storage vaults or hot cells). The record shall be retained as long as the containers are in use for the purpose indicated on the record; or

f) Installed manufacturing or process equipment, such as piping and tanks.

Section 340.960 Procedures for Receiving and Opening Packages

a) Each licensee who is authorized to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in 32 Ill. Adm. Code 341.20, as listed in 49 CFR 173.435 revised as of September 29, 1988, or as derived from 49 CFR 173.433 revised as of March 19, 1985 shall:

1) Make arrangements to receive the package when the carrier offers it for delivery; or

2) Make arrangements to receive the notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

b) Each licensee shall:

1) Monitor the external surfaces of a labeled package for radioactive contamination unless the package contains only radioactive material in the form of a gas or in special form radioactive material as defined in 32 Ill. Adm. Code 310.20;

AGENCY NOTE: Labeled means labeled with a Radioactive White I, Yellow II or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436-440, current as of October 1, 1991, exclusive of subsequent amendments or editions.

2) Monitor the external surfaces of a labeled package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in 32 Ill. Adm. Code 341.20, as listed in 49 CFR 173.435 revised as of September 29, 1988, or as derived from 49 CFR 173.433 revised as of March 19, 1985; and

3) Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet or damaged.

c) The licensee shall perform the monitoring required by subsection (b) above as soon as practicable after receipt of the package, but not later than 3 hours after the package is received at the licensee's facility if it is received during the licensee's normal working hours or if there is evidence of degradation of package integrity, such as a package that is crushed, wet or damaged. If a package is received after working hours, and has no evidence of degradation of package integrity, the package shall be monitored no later than 3 hours from the beginning of the next working day.

d) The licensee shall immediately notify the final delivery carrier and the Department, by telephone and either telegram, mailgram or facsimile, when:

1) Removable radioactive surface contamination exceeds the limits of 32 Ill. Adm. Code 341.150(h); or

2) External radiation levels exceed the limits of 32 Ill. Adm. Code 341.150(i) and (j).

e) Each licensee shall:

1) Establish, maintain and retain written procedures for safely opening packages in which radioactive material is received; and

2) Ensure that the procedures are followed and that special instructions for the type of package being opened are adhered to.

SUBPART K: WASTE DISPOSAL

Section 340.1010 General Requirements

a) A licensee shall dispose of licensed material only:

1) By transfer to an authorized recipient as provided in Section 340.1060 or in 32 Ill. Adm. Code 330, 332 or 601, or to the U.S. Department of Energy; or

2) By release in effluents within the limits in Section 340.310; or

3) As authorized pursuant to Sections 340.1020, 340.1030, 340.1040 or 340.1050.

b) A person shall be specifically licensed by the Department prior to receiving waste containing licensed material from any other point of generation for:

1) Treatment prior to disposal; or

2) Treatment or disposal by incineration; or

3) Disposal at a land disposal facility licensed pursuant to 32 Ill. Adm. Code 601; or

4) Storage until transferred to a disposal facility authorized to receive the waste.

Section 340.1020 Method for Obtaining Approval of Proposed Disposal Procedures

A licensee or applicant for a license may apply to the Department for approval of proposed procedures, not otherwise authorized in 32 Ill. Adm. Code: Chapter II, Subchapters b and d, to dispose of licensed material generated in the licensee's operations. Each application shall include:

a) A description of the waste containing licensed material to be disposed of, including the physical and chemical properties that have an impact on risk evaluation, and the proposed manner and conditions of waste disposal;

b) An analysis and evaluation of pertinent information on the nature of the environment;

c) The nature and location of other potentially affected facilities; and

d) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in this Part.

Section 340.1030 Disposal by Release into Sanitary Sewerage

a) A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

1) The material is readily soluble, or is readily dispersible biological material, in water;

2) The quantity of licensed radioactive material that the licensee releases into the sewer in 1 month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in Table 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions;

3) If more than one radionuclide is released, the following conditions must also be satisfied:

A) The licensee shall determine the fraction of the limit in Table 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions, represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in Table 3 of Appendix B to 10 CFR 20.1001 - 20.2401, effective January 1, 1994, exclusive of subsequent amendments or editions; and

B) The sum of the fractions for each radionuclide required by subsection (a)(3)(A) above does not exceed unity;

4) The total quantity of licensed radioactive material that the licensee releases into sanitary sewerage in a year does not exceed 185 GBq (5 Ci) of hydrogen-3, 37 GBq (1 Ci) of carbon-14, and 37 GBq (1 Ci) of all other radioactive materials combined; and

5) In determining compliance with subsections (a)(1), (a)(2), (a)(3) and (a)(4) above, the licensee shall not include the activity from radioactive material excluded by subsection (b) below.

b) Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in subsection (a) above.

Section 340.1040 Treatment or Disposal by Incineration

A licensee may treat or dispose of licensed material by incineration only in the amounts and forms specified in Section 340.1050 or as specifically approved by the Department pursuant to Section 340.1020.

Section 340.1050 Disposal of Specific Wastes

a) A licensee may dispose of the following licensed material as if it were not radioactive:

1) 1.85 kBq (0.05 uCi), or less, of hydrogen-3, carbon-14 or iodine-125 per gram of medium used for scintillation counting; and

2) 1.85 kBq (0.05 uCi), or less, of hydrogen-3, carbon-14 or iodine-125 per gram of animal tissue, averaged over the weight of the entire animal.

b) A licensee shall not dispose of tissue pursuant to subsection (a)(2) above in a manner that would permit its use either as food for humans or as animal feed.

c) The licensee shall maintain records in accordance with Section 340.1180.

Section 340.1052 Classification of Radioactive Waste for Land Disposal

a) Considerations. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form and disposal methods are effective.

b) Classes of waste.

1) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in Section 340.1055(a). If Class A waste also meets the stability requirements set forth in Section 340.1055(b), it is not necessary to segregate the waste for disposal.

2) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability (as defined in 32 Ill. Adm. Code 601.20) after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in Section 340.1055.

3) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in Section 340.1055.

c) Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table 1 below, classification shall be determined as follows:

1) If the concentration does not exceed 0.1 times the value in Table 1 below, the waste is Class A.

2) If the concentration exceeds 0.1 times the value in Table 1 below, but does not exceed the value in Table 1 below, the waste is Class C.

3) If the concentration exceeds the value in Table 1 below, the waste is not generally acceptable for land disposal.

4) For wastes containing mixtures of radionuclides listed in Table 1 below, the total concentration shall be determined by the sum of fractions rule described in subsection (g) below.

Table 1

Radionuclide	Concentration curies/cubic meter
C-14	8
C-14 in activated metal	80
Ni-59 in activated metal	220
Nb-94 in activated metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting transuranic radionuclides with half-life greater than five years	100*

Pu-241	3,500*
Cm-242	20,000*
Ra-226	100*

*AGENCY NOTE: Units are nanocuries per gram.

d) Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table 1 above, classification shall be determined based on the concentrations shown in Table 2 below. However, as specified in subsection (f) below, if radioactive waste does not contain any nuclides listed in either Table 1 above or Table 2 below, it is Class A.

1) If the concentration does not exceed the value in Column 1, the waste is Class A.

2) If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.

3) If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.

4) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

5) For wastes containing mixtures of the radionuclides listed in Table 2 below, the total concentration shall be determined by the sum of fractions rule described in subsection (g) below.

Table 2

Radionuclide	Concentration, curies/cubic meter		
	Column 1	Column 2	Column 3
Total of all radionuclides with less than 5-year half-life	700	--	--
H-3	40	--	--
Co-60	700	--	--
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

AGENCY NOTE: There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table 2 above determine the waste to be Class C independent of these radionuclides.

e) Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table 1 above and some of which are listed in Table 2 above, classification shall be determined as follows:

1) If the concentration of a radionuclide listed in Table 1 above is less than 0.1 times the value listed in Table 1 above, the class shall be that determined by the concentration of radionuclides listed in Table 2 above.

2) If the concentration of a radionuclide listed in Table 1 above exceeds 0.1 times the value listed in Table 1 above, but does not exceed the value in Table 1 above, the waste shall be Class C, provided the concentration of radionuclides listed in Table 2 above does not exceed the value shown in Column 3 of Table 2 above.

f) Classification of wastes with radionuclides other than those listed in Tables 1 and 2 above. If the waste does not contain any radionuclides listed in either Tables 1 or 2 above, it is Class A.

g) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 50 Ci/m^3 and Cs-137 in a concentration of 22 Ci/m^3. Since the concentrations both exceed the values in Column 1, Table 2, they must be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33, for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

h) Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nano-curies per gram.

Section 340.1055 Radioactive Waste Characteristics

a) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and

safety of personnel at the disposal site.

1) Wastes shall be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of this Part, the site license conditions shall govern.

2) Wastes shall not be packaged for disposal in cardboard or fiberboard boxes.

3) Liquid waste shall be packaged in sufficient absorbent material to absorb twice the volume of the liquid.

4) Solid waste containing liquid shall contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.

5) Waste shall not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

6) Waste shall not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with subsection (a)(8) below.

7) Waste must not be pyrophoric. Pyrophoric materials contained in wastes shall be treated, prepared and packaged to be nonflammable. (See 32 Ill. Adm. Code 601 for definition of pyrophoric.)

8) Wastes in a gaseous form shall be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20°C (68°F). Total activity shall not exceed 100 Ci per container.

9) Wastes containing hazardous, biological, pathogenic or infectious material shall be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

b) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

1) Waste shall have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

2) Notwithstanding the provisions in subsections (a)(3) and (a)(4) above, liquid wastes, or wastes containing liquid, shall be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.

3) Void spaces within the waste and between the waste and its package shall be reduced to the extent practicable.

Section 340.1057 Labeling

Each package of waste shall be clearly labeled to identify whether it is Class A, Class B or Class C waste, in accordance with Section 340.1052.

Section 340.1060 Transfer for Disposal and Manifests

a) Each shipment of radioactive waste to a licensed land disposal facility shall be accompanied by a shipment manifest that contains the name, address and telephone number of the person generating the waste, as well as the name, address and telephone number or the name and U.S. Environmental Protection Agency hazardous waste identification number of the person transporting the waste. The manifest shall also indicate as completely as practicable: a physical description of the waste; the waste volume; radionuclide identity and quantity; the total radioactivity; and the principal chemical form. The solidification agent shall be specified. Wastes containing more than 0.1% chelating agents by weight shall be identified and the weight percentage of the chelating agent shall be estimated. Wastes classified as Class A, Class B or Class C in Section 340.1052 shall be clearly identified as such in the manifest. The total quantity of the radionuclides H-3, C-14, Tc-99 and I-129 shall be shown.

b) The manifest required by this Section may be shipping papers used to meet USDOT or U.S. Environmental Protection Agency regulations (i.e., 40 CFR 262 and 263, revised as of July, 1984, exclusive of subsequent amendments or editions), or requirements of the receiver, provided all the required information is included.

c) Each manifest shall include a certification by the waste generator that the materials being

transported are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the USDOT and the Department. An authorized representative of the waste generator shall sign and date the manifest.

d) Any licensee who transfers waste to a land disposal facility or a licensed waste collector shall comply with the following requirements. Any licensee who transfers waste to a licensed waste processor who treats or repackages waste shall comply with the requirements of subsections (d)(4) through (d)(8) below. A licensee shall:

1) Prepare all wastes so that the waste is classified according to Section 340.1052 and meets the waste characteristics requirements in Section 340.1055;

2) Label each package of waste to identify whether it is Class A waste, Class B waste or Class C waste, in accordance with Section 340.1052;

3) Conduct a quality control program to assure compliance with Sections 340.1052 and 340.1055; the program must include management evaluation of audits;

4) Prepare shipping manifests to meet the requirements of subsections (a) and (c) above;

5) Forward a copy of the manifest to the intended recipient at the time of shipment; or, deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest from the collector;

6) Include one copy of the manifest with the shipment;

7) Retain a copy of the manifest with documentation of acknowledgement of receipt as the record of transfer of licensed material as required by this Part; and

8) For any shipments or any part of a shipment for which acknowledgement of receipt has not been received within the times set forth in this Section, conduct an investigation in accordance with this Section.

e) Any waste collector licensee who handles only prepackaged waste shall:

1) Acknowledge receipt of the waste from the generator within one week after receipt by returning a signed copy of the manifest to the generator;

2) Prepare a new manifest to reflect consolidated shipments; the new manifest shall serve as a listing or index for the detailed generator manifests. Copies of the generator manifests shall be a part of the new manifest. The waste collector may prepare a new manifest without attaching the generator manifests, provided the new manifest contains for each package the information specified in subsection (a) above. The collector licensee shall certify that nothing has been done to the waste which would invalidate the generator's certification;

3) Forward a copy of the new manifest to the land disposal facility operator at the time of shipment;

4) Include the new manifest with the shipment to the disposal site;

5) Retain a copy of the manifest with documentation of acknowledgement of receipt as the record of transfer of licensed material as required by this Part, and retain information from generator manifests until disposition is authorized by the Department; and

6) For any shipments or any part of a shipment for which acknowledgement of receipt is not received within the times set forth in this Section, conduct an investigation in accordance with subsection (h) below.

f) Any licensed waste processor who treats or repackages wastes shall:

1) Acknowledge receipt of the waste from the generator within one week after receipt by returning a signed copy of the manifest to the generator;

2) Prepare a new manifest that meets the requirements of subsections (a), (b) and (c) above. Preparation of the new manifest reflects that the processor is responsible for the waste;

3) Prepare all wastes so that the waste is classified according to Section 340.1052 and meets the waste characteristics requirement in Section 340.1055;

4) Label each package of waste to identify whether it is Class A waste, Class B waste or Class C waste, in accordance with Sections 340.1052 and 340.1057 of this Part;

5) Conduct a quality control program to assure compliance with Sections 340.1052 and 340.1055. This program shall include management evaluation of audits;

6) Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest by the collector;

7) Include the new manifest with the shipment;

8) Retain copies of original manifests and new

manifests with documentation of acknowledgement of receipt as the record of transfer of licensed material as required by this Part; and

9) For any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this Section, conduct an investigation in accordance with subsection (h) below.

g) The land disposal facility operator shall:

1) Acknowledge receipt of the waste within one week after receipt by returning a signed copy of the manifest to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest shall indicate any discrepancies between materials listed on the manifest and materials received;

2) Retain a copy of the manifest with documentation of acknowledgement of receipt as the record of transfer of licensed material as required by this Part, and retain information from generator manifests until disposition is authorized by the Department; and

3) Notify the shipper (i.e., the generator, the collector or processor) and the Department when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.

h) Any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this Section must:

1) Be investigated by the shipper if the shipper has not received notification of receipt within 20 days after transfer; and

2) Be traced and reported. The investigation shall include tracing the shipment and filing a report with the Department. Each licensee who conducts a trace investigation shall file a written report with the Department within 2 weeks after completion of the investigation.

Section 340.1070 Compliance with Environmental and Health Protection Regulations

Nothing in this Subpart K relieves the licensee from complying with other applicable federal, State and local regulations governing any other toxic or hazardous properties of materials that are disposed of pursuant to this Subpart.

SUBPART L: RECORDS

Section 340.1110 General Provisions

a) Each licensee or registrant shall use the SI units becquerel, gray, sievert and coulomb/kilogram or the special units curie, rad, rem and roentgen, including multiples and subdivisions, and shall clearly indicate the units of all quantities on records required by this Part.

b) The licensee or registrant shall make a clear distinction among the quantities entered on the records required by this Part (e.g., total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, eye dose equivalent, deep dose equivalent, committed effective dose equivalent).

c) No licensee or registrant shall subtract radiation exposures from official personnel monitoring records without the prior written approval of the Department.

Section 340.1120 Records of Radiation Protection Programs

a) Each licensee or registrant shall maintain records of the radiation protection program required pursuant to Section 340.110, including:

1) The provisions of the program; and

2) Audits and other reviews of program content and implementation.

b) The licensee or registrant shall retain the records required by subsection (a)(1) above until the Department terminates each license or registration for which the record is required. The licensee or registrant shall retain the records required by subsection (a)(2) above for 5 years after the record is made.

Section 340.1130 Records of Surveys

a) Each licensee or registrant shall maintain records showing the results of surveys and calibrations required by Sections 340.510 and 340.960(b). The licensee or registrant shall retain these records for 5 years after the record is made.

b) The licensee or registrant shall retain each of the following records until the Department terminates each license or registration for which the record is required:

1) Records of the results of surveys to determine the dose from external sources of radiation that are used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents;

2) Records of the results of measurements and calculations that are used to determine individual intakes of radioactive material and that are used in the assessment of internal dose;

3) Records showing the results of air sampling, surveys and bioassays required pursuant to Sections 340.730(a)(3)(A) and (B); and

4) Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.

Section 340.1135 Records of Tests for Leakage or Contamination of Sealed Sources

Records of tests for leakage or contamination required by Section 340.410 shall be kept in units of becquerel or microcurie and maintained for inspection by the Department for 5 years after the records are made.

Section 340.1140 Records of Prior Occupational Dose

a) The licensee or registrant shall retain the records of prior occupational dose and exposure history as specified in Section 340.250 until the Department terminates each pertinent license or registration requiring this record. The licensee or registrant shall retain records used in preparing the prior occupational dose and exposure history for 3 years after the record is made.

b) Upon termination of the license or registration, the records of prior occupational dose and exposure history shall be transferred to the Department.

Section 340.1150 Records of Planned Special Exposures

a) For each use of the provisions of Section 340.260 for planned special exposures, the licensee shall maintain records that describe:

1) The exceptional circumstances requiring the use of a planned special exposure;

2) The name of the management official who authorized the planned special exposure and a copy of the signed authorization;

3) What actions were necessary;

4) Why the actions were necessary;

5) What precautions were taken to assure that doses were maintained ALARA;

6) What individual and collective doses were expected to result; and

7) The doses actually received in the planned special exposure.

b) The licensee shall retain the records until the Department terminates each license for which these records are required.

c) Upon termination of the license, the records of doses received during planned special exposures shall be transferred to the Department.

Section 340.1160 Records of Individual Monitoring Results

a) Recordkeeping Requirement. Each licensee or registrant shall maintain records of doses received by all individuals for whom monitoring was required pursuant to Section 340.520, and records of doses received during planned special exposures, accidents and emergency conditions. These records shall include, when applicable:

1) The deep dose equivalent to the whole body, eye dose equivalent, shallow dose equivalent to the skin and shallow dose equivalent to the extremities;

2) The estimated intake of radionuclides (see Section 340.220);

3) The committed effective dose equivalent assigned to the intake of radionuclides;

4) The specific information used to calculate the committed effective dose equivalent pursuant to Section 340.240(c);

5) The total effective dose equivalent when required by Section 340.220; and

6) The total of the deep dose equivalent and the committed dose equivalent to the organ receiving the highest total dose.

AGENCY NOTE: Assessments of dose equivalent and records made using units in effect before January 1, 1994, need not be changed.

b) Recordkeeping Frequency. The licensee or registrant shall make entries of the records specified in subsection (a) above at intervals not to exceed 1 year.

c) Recordkeeping Format. The licensee or registrant shall maintain the records specified in subsection (a) above on IDNS Form 4 or 5, as applicable, in accordance with the instructions for the forms, or in clear and legible records containing all the information required by the forms.

d) The licensee or registrant shall maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy, and the estimated date of conception, shall also be kept on file, but may be maintained separately from the dose records.

e) The licensee or registrant shall retain each required form or record until the Department terminates each license or registration for which the record is required.

f) Upon termination of the license or registration, the records of doses received by individuals shall be transferred to the Department.

Section 340.1170 Records of Dose to Members of the Public

a) Each licensee or registrant shall maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public (see Sections 340.310 and 340.320).

b) The licensee or registrant shall retain the records required by subsection (a) above until the

Department terminates each license or registration for which the record is required.

Section 340.1180 Records of Waste Disposal

a) Each licensee shall maintain records of the disposal of licensed materials made pursuant to Sections 340.1020, 340.1030, 340.1040, 340.1050, 340.1060 and 32 Ill. Adm. Code 601. Each licensee shall also maintain records of disposal by burial in soil, including burials authorized before January 28, 1981, pursuant to 10 CFR 20.304.

AGENCY NOTE: Prior to January 28, 1981, the U.S. Nuclear Regulatory Commission permitted licensees to dispose of small quantities of licensed materials by burial in soil without specific Nuclear Regulatory Commission authorization. This was authorized pursuant to 10 CFR 20.304.

b) The licensee shall retain the records required by subsection (a) above until the Department terminates each license for which the record is required.

Section 340.1190 Records of Testing Entry Control Devices for Very High Radiation Areas

a) Each licensee or registrant shall maintain records of tests made pursuant to Section 340.630(b)(9) on entry control devices for very high radiation areas. These records must include the date, time and results of each such test of function.

b) The licensee or registrant shall retain the records required by subsection (a) above for 3 years after the record is made.

Section 340.1195 Form of Records

Each record required by this Part shall be legible throughout the specified retention period. The record shall be the original or a reproduced copy or a microform provided that the copy or microform is authenticated by authorized personnel. The microform shall be capable of producing a clear copy throughout the required retention period. Records may be stored in electronic media with the capability for producing legible, accurate and complete records during the required retention period. Records, such as letters, drawings and specifications, shall include all pertinent information, such as stamps, initials and signatures. The licensee or registrant shall maintain adequate safeguards against tampering with and loss of records.

SUBPART M: REPORTS AND NOTIFICATIONS

Section 340.1210 Reports of Stolen, Lost or Missing Sources of Radiation

a) Telephone Reports. Each licensee or registrant shall report to the Department by telephone each stolen, lost or missing source of radiation immediately after its absence becomes known to the licensee or registrant. This requirement does not apply to sources of radiation that are not required to be licensed or registered.

b) Written Reports. Each licensee or registrant required to make a report pursuant to subsection (a) above shall, within 30 days after making the telephone report, make a written report to the Department setting forth the following information:

1) A description of the source of radiation involved, including for radioactive material, the kind, quantity and chemical and physical form; and, for radiation machines, the type of unit, the manufacturer, model and serial number;

2) A description of the circumstances under which the loss or theft occurred;

3) A statement of disposition, or probable disposition, of the source of radiation involved;

4) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas;

5) Actions that have been taken, or will be taken, to recover the source of radiation; and

6) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the theft or loss of sources of radiation.

c) Subsequent to filing the written report, the licensee or registrant shall also report any additional substantive information on the loss or theft within 30 days after the licensee or registrant learns of such information.

d) The licensee or registrant shall prepare any report filed with the Department pursuant to this Section so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.

Section 340.1220 Notification of Incidents

a) Immediate Notification. Notwithstanding any other requirements for notification, each licensee or registrant shall immediately report to the Department each event involving a source of radiation possessed by the licensee or registrant that may have caused or threatens to cause any of the following conditions:

1) An individual to receive:

A) A total effective dose equivalent of 0.25 Sv (25 rem) or more; or

B) An eye dose equivalent of 0.75 Sv (75 rem) or more; or

C) A shallow dose equivalent to the skin or extremities or a total organ dose equivalent of 2.5 Gy (250 rad) or more; or

2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the ALI, except the provisions of this subsection do not apply to locations where personnel are not normally stationed during routine operations, such as hot cells or process enclosures.

b) Twenty-four Hour Notification. Each licensee or registrant shall, within 24 hours of discovery of the event, report to the Department each event involving loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause, any of the following conditions:

1) An individual to receive, in a period of 24 hours:

A) A total effective dose equivalent exceeding 0.05 Sv (5 rem); or

B) An eye dose equivalent exceeding 0.15 Sv (15 rem); or

C) A shallow dose equivalent to the skin or extremities or a total organ dose equivalent exceeding 0.5 Sv (50 rem); or

2) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational ALI, except the provisions of this subsection do not apply to locations where personnel are not normally stationed during routine operations, such as hot cells or process enclosures.

c) Licensees or registrants shall make the reports required by subsections (a) and (b) above by initial contact by telephone to the Department and shall confirm the initial contact by telegram, mailgram, or facsimile to the Department.

d) The licensee or registrant shall prepare each written report filed with the Department pursuant to this Section so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

e) The provisions of this Section do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported pursuant to Section 340.1240.

Section 340.1230 Reports of Exposures, Radiation Levels and Concentrations of Radioactive Material Exceeding the Limits

a) Reportable Events. In addition to the notification required by Section 340.1220, each licensee or registrant shall submit a written report to the Department within 30 days after learning of any of the following occurrences:

1) Incidents for which notification is required by Section 340.1220; or

2) Doses in excess of any of the following:

A) The occupational dose limits for adults in Section 340.210; or

B) The occupational dose limits for a minor in Section 340.270; or

C) The limits for an embryo/fetus of a declared pregnant woman in Section 340.280; or

D) The limits for an individual member of the public in Section 340.310; or

E) Any applicable limit in the license; or

3) Levels of radiation or concentrations of radioactive material in:

A) A restricted area in excess of any applicable limit in the license; or

B) An unrestricted area in excess of ten times any applicable limit set forth in this Part or ten times any applicable limit set forth in the license, whether or not involving exposure of any individual in excess of the limits in Section 340.310; or

4) For licensees subject to the provisions of the U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190, effective July 1, 1990, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

b) Contents of Reports

1) Each report required by subsection (a) above shall describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

A) Estimates of each individual's dose;

B) The levels of radiation and concentrations of radioactive material involved;

C) The cause of the elevated exposures, dose rates or concentrations; and

D) Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, generally applicable environmental standards and associated license conditions.

2) Each report filed pursuant to subsection (a) above shall include for each individual exposed: the name, Social Security account number and date of birth. With respect to the limit for the embryo/fetus in Section

340.280, the identifiers shall be those of the declared pregnant woman. The report shall be prepared so that this information is stated in a separate and detachable portion of the report.

Section 340.1240 Reports of Planned Special Exposures

The licensee shall submit a written report to the Department within 30 days following any planned special exposure conducted in accordance with Section 340.260, informing the Department that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by Section 340.1150.

Section 340.1250 Notifications and Reports to Individuals

a) Requirements for notification and reports to individuals of exposure to radiation or radioactive material are specified in 32 Ill. Adm. Code 400.130.

b) When a licensee or registrant is required pursuant to Section 340.1230 to report to the Department any exposure of an individual to radiation or radioactive material, the licensee or registrant shall also notify the individual. Such notice shall be transmitted at a time not later than the transmittal to the Department, and shall comply with the provisions of 32 Ill. Adm. Code 400.130(a).

Section 340.1260 Reports of Leaking or Contaminated Sealed Sources

The licensee shall file a report within 5 days with the Department if the test for leakage or contamination required pursuant to Section 340.410 indicates a sealed source is leaking or contaminated. The report shall describe the equipment involved, the test results and the corrective action taken.

Section 340.1270 Reports of Missing Waste Shipments

Each licensee who conducts a trace investigation pursuant to Section 340.1060 (h) shall file a written report with the Department within 2 weeks after completion of the investigation.

SUBPART N: ADDITIONAL REQUIREMENTS

Section 340.1310 Vacating Premises

Each specific licensee shall, no less than 30 days before vacating or relinquishing possession or control of premises which may have been contaminated with radioactive material as a result of his activities, notify the Department in writing of intent to vacate.

Section 340.1320 Removal of Radioactive Contamination

Notwithstanding any exemptions contained in this Part, any person who uses, possesses, or stores radioactive material in such a manner as to cause uncontrolled contamination of any area shall, upon order of the Department, remove or provide for the removal of such contaminants at his own expense through the use of an authorized transferee and shall decontaminate the installation to the lowest practicable level. Unless another value is specified in 32 Ill. Adm. Code 332, the values specified in Section 340.Appendix A may be used as guidelines for this purpose. These values, however, may be modified at specific installations at the discretion of the Department.

Section 340.Appendix A Decontamination Guidelines

a) Surface Contamination Guide

Alpha Emitters:

Removable	555	mBq per 100 cm^2 =	average
	15	pCi per 100 cm^2 =	over any
	33	dpm per 100 cm^2	one surface
	1.67	Bq per 100 cm^2 =	
	45	pCi per 100 cm^2 =	maximum
	100	dpm per 100 cm^2	
Total (fixed)	16.7	Bq per 100 cm^2 =	average
	450	pCi per 100 cm^2 =	over any
	1,000	dpm per 100 cm^2	one surface
	83.3	Bq per 100 cm^2 =	
	2,250	pCi per 100 cm^2 =	maximum
	5,000	dpm per 100 cm^2	
	2.5	microSv per hour at 1 cm from surface =	
	250	microrem per hour at 1 cm from surface	

Beta-Gamma Emitters:

Removable (all beta-gamma emitters except hydrogen-3)	3.7	Bq per 100 cm^2 =	average over any one surface
	100	pCi per 100 cm^2	
	18.5	Bq per 100 cm^2 =	maximum
	500	pCi per 100 cm^2	
Removable (hydrogen-3)	37	Bq per 100 cm^2 =	average over any one surface
	1,000	pCi per 100 cm^2	
	185	Bq per 100 cm^2 =	maximum
	5,000	pCi per 100 cm^2	
Total (fixed)	2.5	microSv per hour at 1 cm from surface =	
	250	mocrprem per hour at 1 cm from surface	

b) Concentration in air and water: Appendix B, Table I and II of 10 CFR 20.

c) Concentrations in soil and other materials except water:

1) Radioactive material except source material and radium: Column II of 32 Ill. Adm. Code 330.Appendix A.

2) Source material and radium: Concentration of radionuclides above background concentrations for total radium, averaged over areas of 100 square meters, shall not exceed:

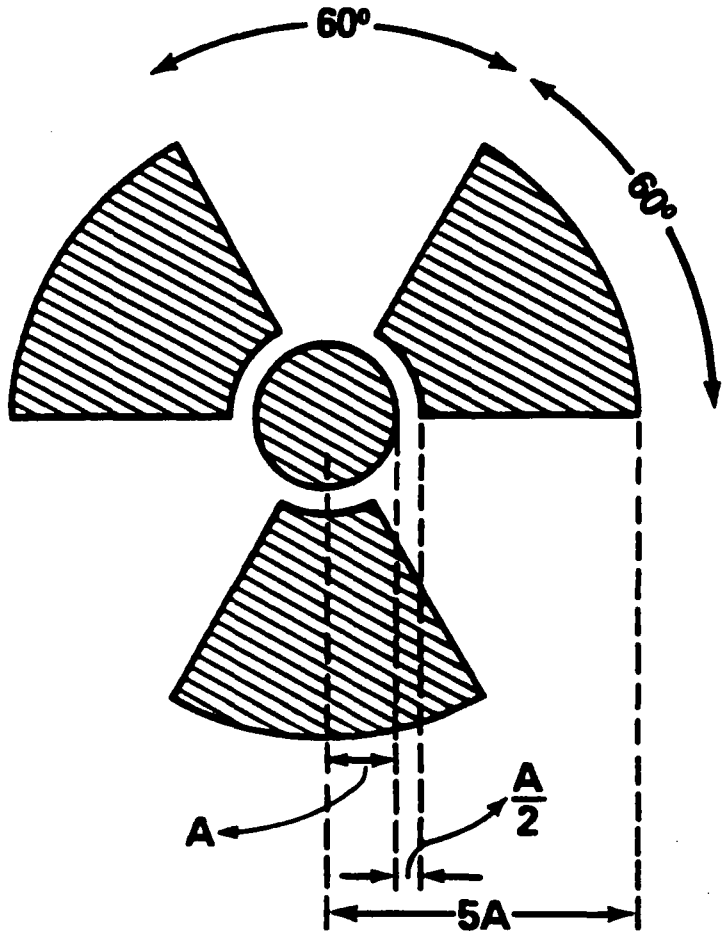
A) 185 mBq (5 pCi) per gram of dry soil, averaged over the first 15 centimeters below the surface; and

B) 185 mBq (5 pCi) per gram of dry soil, averaged over layers of 15 centimeters thickness more than 15 centimeters below the surface.

d) The level of gamma radiation measured at a distance of 100 centimeters from the surface shall not exceed background.

AGENCY NOTE: This Appendix shall be used only as a guide. The Department may require lower values in specific instances, depending upon radionuclides, type of surface, intended present and future use, etc.

Section 340.Illustration A Radiation Symbol



9. Part 20 is amended by adding appendix C to §§ 20.1001–20.2401 to read as follows:

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)
Hydrogen-3	1,000
Beryllium-7	1,000
Beryllium-10	1
Carbon-11	1,000
Carbon-14	1,000
Fluorine-18	1,000
Sodium-22	10
Sodium-24	100
Magnesium-28	100
Aluminum-26	10
Silicon-31	1,000
Silicon-32	1
Phosphorus-32	10
Phosphorus-33	100
Sulfur-35	100
Chlorine-36	10
Chlorine-38	1,000
Chlorine-39	1,000
Argon-39	1,000
Argon-41	1,000
Potassium-40	100
Potassium-42	1,000
Potassium-43	1,000
Potassium-44	1,000
Potassium-45	1,000
Calcium-41	100
Calcium-45	100
Calcium-47	100
Scandium-43	1,000
Scandium-44m	100
Scandium-44	100
Scandium-46	10
Scandium-47	100
Scandium-48	100
Scandium-49	1,000
Titanium-44	1
Titanium-45	1,000
Vanadium-47	1,000
Vanadium-48	100
Vanadium-49	1,000
Chromium-48	1,000
Chromium-49	1,000
Chromium-51	1,000
Manganese-51	1,000
Manganese-52m	1,000
Manganese-52	100
Manganese-53	1,000
Manganese-54	100
Manganese-56	1,000
Iron-52	100
Iron-55	100
Iron-59	10
Iron-60	1
Cobalt-55	100
Cobalt-56	10
Cobalt-57	100
Cobalt-58m	1,000
Cobalt-58	100
Cobalt-60m	1,000
Cobalt-60	1
Cobalt-61	1,000
Cobalt-62m	1,000
Nickel-56	100
Nickel-57	100
Nickel-59	100
Nickel-63	100
Nickel-65	1,000
Nickel-66	10
Copper-60	1,000
Copper-61	1,000
Copper-64	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Copper-67	1,000
Zinc-62	100
Zinc-63	1,000
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zinc-71m	1,000
Zinc-72	100
Gallium-65	1,000
Gallium-66	100
Gallium-67	1,000
Gallium-68	1,000
Gallium-70	1,000
Gallium-72	100
Gallium-73	1,000
Germanium-66	1,000
Germanium-67	1,000
Germanium-68	10
Germanium-69	1,000
Germanium-71	1,000
Germanium-75	1,000
Germanium-77	1,000
Germanium-78	1,000
Arsenic-69	1,000
Arsenic-70	1,000
Arsenic-71	100
Arsenic-72	100
Arsenic-73	100
Arsenic-74	100
Arsenic-76	100
Arsenic-77	100
Arsenic-78	1,000
Selenium-70	1,000
Selenium-73m	1,000
Selenium-73	100
Selenium-75	100
Selenium-79	100
Selenium-81m	1,000
Selenium-81	1,000
Selenium-83	1,000
Bromine-74m	1,000
Bromine-74	1,000
Bromine-75	1,000
Bromine-76	100
Bromine-77	1,000
Bromine-80m	1,000
Bromine-80	1,000
Bromine-82	100
Bromine-83	1,000
Bromine-84	1,000
Krypton-74	1,000
Krypton-76	1,000
Krypton-77	1,000
Krypton-79	1,000
Krypton-81	1,000
Krypton-83m	1,000
Krypton-85m	1,000
Krypton-85	1,000
Krypton-87	1,000
Krypton-88	1,000
Rubidium-79	1,000
Rubidium-81m	1,000
Rubidium-81	1,000
Rubidium-82m	1,000
Rubidium-83	100
Rubidium-84	100
Rubidium-86	100
Rubidium-87	100
Rubidium-88	1,000
Rubidium-89	1,000
Strontium-80	100
Strontium-81	1,000
Strontium-83	100
Strontium-85m	1,000
Strontium-85	100
Strontium-87m	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Strontium-89	10
Strontium-90	0.1
Strontium-91	100
Strontium-92	100
Yttrium-86m	1,000
Yttrium-86	100
Yttrium-87	100
Yttrium-88	10
Yttrium-90m	1,000
Yttrium-90	10
Yttrium-91m	1,000
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Yttrium-94	1,000
Yttrium-95	1,000
Zirconium-86	100
Zirconium-88	10
Zirconium-89	100
Zirconium-93	1
Zirconium-95	10
Zirconium-97	100
Niobium-88	1,000
Niobium-89m (66 min)	1,000
Niobium-89 (122 min)	1,000
Niobium-90	100
Niobium-93m	10
Niobium-94	1
Niobium-95m	100
Niobium-95	100
Niobium-96	100
Niobium-97	1,000
Niobium-98	1,000
Molybdenum-90	100
Molybdenum-93m	100
Molybdenum-93	10
Molybdenum-99	100
Molybdenum-101	1,000
Technetium-93m	1,000
Technetium-93	1,000
Technetium-94m	1,000
Technetium-94	1,000
Technetium-96m	1,000
Technetium-96	100
Technetium-97m	100
Technetium-97	1,000
Technetium-98	10
Technetium-99m	1,000
Technetium-99	100
Technetium-101	1,000
Technetium-104	1,000
Ruthenium-94	1,000
Ruthenium-97	1,000
Ruthenium-103	100
Ruthenium-105	1,000
Ruthenium-106	1
Rhodium-99m	1,000
Rhodium-99	100
Rhodium-100	100
Rhodium-101m	1,000
Rhodium-101	10
Rhodium-102m	10
Rhodium-102	10
Rhodium-103m	1,000
Rhodium-105	100
Rhodium-106m	1,000
Rhodium-107	1,000
Palladium-100	100
Palladium-101	1,000
Palladium-103	100
Palladium-107	10
Palladium-109	100
Silver-102	1,000
Silver-103	1,000
Silver-104m	1,000
Silver-104	1,000

APPENDIX C TO §§ 20.1001-20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Silver-105	100
Silver-106m	100
Silver-106	1,000
Silver-108m	1
Silver-110m	10
Silver-111	100
Silver-112	100
Silver-115	1,000
Cadmium-104	1,000
Cadmium-107	1,000
Cadmium-109	1
Cadmium-113m	0.1
Cadmium-113	100
Cadmium-115m	10
Cadmium-115	100
Cadmium-117m	1,000
Cadmium-117	1,000
Indium-109	1,000
Indium-110 (69.1min.)	1,000
Indium-110 (4.9h)	1,000
Indium-111	100
Indium-112	1,000
Indium-113m	1,000
Indium-114m	10
Indium-115m	1,000
Indium-115	100
Indium-116m	1,000
Indium-117m	1,000
Indium-117	1,000
Indium-119m	1,000
Tin-110	100
Tin-111	1,000
Tin-113	100
Tin-117m	100
Tin-119m	100
Tin-121m	100
Tin-121	1,000
Tin-123m	1,000
Tin-123	10
Tin-125	10
Tin-126	10
Tin-127	1,000
Tin-128	1,000
Antimony-115	1,000
Antimony-116m	1,000
Antimony-116	1,000
Antimony-117	1,000
Antimony-118m	1,000
Antimony-119	1,000
Antimony-120 (16min.)	1,000
Antimony-120 (5.76d)	100
Antimony-122	100
Antimony-124m	1,000
Antimony-124	10
Antimony-125	100
Antimony-126m	1,000
Antimony-126	100
Antimony-127	100
Antimony-128 (10.4min.)	1,000
Antimony-128 (9.01h)	100
Antimony-129	100
Antimony-130	1,000
Antimony-131	1,000
Tellurium-116	1,000
Tellurium-121m	10
Tellurium-121	100
Tellurium-123m	10
Tellurium-123	100
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	1,000
Tellurium-129m	10
Tellurium-129	1,000
Tellurium-131m	10
Tellurium-131	100

APPENDIX C TO §§ 20.1001-20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Tellurium-132	10
Tellurium-133m	100
Tellurium-133	1,000
Tellurium-134	1,000
Iodine-120m	1,000
Iodine-120	100
Iodine-121	1,000
Iodine-123	100
Iodine-124	10
Iodine-125	1
Iodine-126	1
Iodine-128	1,000
Iodine-129	1
Iodine-130	10
Iodine-131	1
Iodine-132m	100
Iodine-132	100
Iodine-133	10
Iodine-134	1,000
Iodine-135	100
Xenon-120	1,000
Xenon-121	1,000
Xenon-122	1,000
Xenon-123	1,000
Xenon-125	1,000
Xenon-127	1,000
Xenon-129m	1,000
Xenon-131m	1,000
Xenon-133m	1,000
Xenon-133	1,000
Xenon-135m	1,000
Xenon-135	1,000
Xenon-138	1,000
Cesium-125	1,000
Cesium-127	1,000
Cesium-129	1,000
Cesium-130	1,000
Cesium-131	1,000
Cesium-132	100
Cesium-134m	1,000
Cesium-134	10
Cesium-135m	1,000
Cesium-135	100
Cesium-136	10
Cesium-137	10
Cesium-138	1,000
Barium-126	1,000
Barium-128	100
Barium-131m	1,000
Barium-131	100
Barium-133m	100
Barium-133	100
Barium-135m	100
Barium-139	1,000
Barium-140	100
Barium-141	1,000
Barium-142	1,000
Lanthanum-131	1,000
Lanthanum-132	100
Lanthanum-135	1,000
Lanthanum-137	10
Lanthanum-138	100
Lanthanum-140	100
Lanthanum-141	100
Lanthanum-142	1,000
Lanthanum-143	1,000
Cerium-134	100
Cerium-135	100
Cerium-137m	100
Cerium-137	1,000
Cerium-139	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Praseodymium-136	1,000
Praseodymium-137	1,000

APPENDIX C TO §§ 20.1001-20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Praseodymium-138m	1,000
Praseodymium-139	1,000
Praseodymium-142m	1,000
Praseodymium-142	100
Praseodymium-143	100
Praseodymium-144	1,000
Praseodymium-145	100
Praseodymium-147	1,000
Neodymium-136	1,000
Neodymium-138	100
Neodymium-139m	1,000
Neodymium-139	1,000
Neodymium-141	1,000
Neodymium-147	100
Neodymium-149	1,000
Neodymium-151	1,000
Promethium-141	1,000
Promethium-143	100
Promethium-144	10
Promethium-145	10
Promethium-146	1
Promethium-147	10
Promethium-148m	10
Promethium-148	10
Promethium-149	100
Promethium-150	1,000
Promethium-151	100
Samarium-141m	1,000
Samarium-141	1,000
Samarium-142	1,000
Samarium-145	100
Samarium-146	1
Samarium-147	100
Samarium-151	10
Samarium-153	100
Samarium-155	1,000
Samarium-156	1,000
Europium-145	100
Europium-146	100
Europium-147	100
Europium-148	10
Europium-149	100
Europium-150 (12.62h)	100
Europium-150 (34.2y)	1
Europium-152m	100
Europium-152	1
Europium-154	1
Europium-155	10
Europium-156	100
Europium-157	100
Europium-158	1,000
Gadolinium-145	1,000
Gadolinium-146	10
Gadolinium-147	100
Gadolinium-148	0.001
Gadolinium-149	100
Gadolinium-151	10
Gadolinium-152	100
Gadolinium-153	10
Gadolinium-159	100
Terbium-147	1,000
Terbium-149	100
Terbium-150	1,000
Terbium-151	100
Terbium-153	1,000
Terbium-154	100
Terbium-155	1,000
Terbium-156m (5.0h)	1,000
Terbium-156m (24.4h)	1,000
Terbium-156	100
Terbium-157	10
Terbium-158	1
Terbium-160	10
Terbium-161	100
Dysprosium-155	1,000
Dysprosium-157	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Dysprosium-159	100
Dysprosium-165	1,000
Dysprosium-166	100
Holmium-155	1,000
Holmium-157	1,000
Holmium-159	1,000
Holmium-161	1,000
Holmium-162m	1,000
Holmium-162	1,000
Holmium-164m	1,000
Holmium-164	1,000
Holmium-166m	1
Holmium-166	100
Holmium-167	1,000
Erbium-161	1,000
Erbium-165	1,000
Erbium-169	100
Erbium-171	100
Erbium-172	100
Thulium-162	1,000
Thulium-166	100
Thulium-167	100
Thulium-170	10
Thulium-171	10
Thulium-172	100
Thulium-173	100
Thulium-175	1,000
Ytterbium-162	1,000
Ytterbium-166	100
Ytterbium-167	1,000
Ytterbium-169	100
Ytterbium-175	100
Ytterbium-177	1,000
Ytterbium-178	1,000
Lutetium-169	100
Lutetium-170	100
Lutetium-171	100
Lutetium-172	100
Lutetium-173	10
Lutetium-174m	10
Lutetium-174	10
Lutetium-176m	1,000
Lutetium-176	100
Lutetium-177m	10
Lutetium-177	100
Lutetium-178m	1,000
Lutetium-178	1,000
Lutetium-179	1,000
Hafnium-170	100
Hafnium-172	1
Hafnium-173	1,000
Hafnium-175	100
Hafnium-177m	1,000
Hafnium-178m	0.1
Hafnium-179m	10
Hafnium-180m	1,000
Hafnium-181	10
Hafnium-182m	1,000
Hafnium-182	0.1
Hafnium-183	1,000
Hafnium-184	100
Tantalum-172	1,000
Tantalum-173	1,000
Tantalum-174	1,000
Tantalum-175	1,000
Tantalum-176	100
Tantalum-177	1,000
Tantalum-178	1,000
Tantalum-179	100
Tantalum-180m	1,000
Tantalum-180	100
Tantalum-182m	1,000
Tantalum-182	10
Tantalum-183	100
Tantalum-184	100
Tantalum-185	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Tantalum-186	1,000
Tungsten-176	1,000
Tungsten-177	1,000
Tungsten-178	1,000
Tungsten-179	1,000
Tungsten-181	1,000
Tungsten-185	100
Tungsten-187	100
Tungsten-188	10
Rhenium-177	1,000
Rhenium-178	1,000
Rhenium-181	1,000
Rhenium-182 (12.7h)	1,000
Rhenium-182 (64.0h)	100
Rhenium-184m	10
Rhenium-184	100
Rhenium-186m	10
Rhenium-186	100
Rhenium-187	1,000
Rhenium-188m	1,000
Rhenium-188	100
Rhenium-189	100
Osmium-180	1,000
Osmium-181	1,000
Osmium-182	100
Osmium-185	100
Osmium-189m	1,000
Osmium-191m	1,000
Osmium-191	100
Osmium-193	100
Osmium-194	1
Iridium-182	1,000
Iridium-184	1,000
Iridium-185	1,000
Iridium-186	100
Iridium-187	1,000
Iridium-188	100
Iridium-189	100
Iridium-190m	1,000
Iridium-190	100
Iridium-192 (73.8d)	1
Iridium-192m (1.4min.)	10
Iridium-194m	10
Iridium-194	100
Iridium-195m	1,000
Iridium-195	1,000
Platinum-186	1,000
Platinum-188	100
Platinum-189	1,000
Platinum-191	100
Platinum-193m	100
Platinum-193	1,000
Platinum-195m	100
Platinum-197m	1,000
Platinum-197	100
Platinum-199	1,000
Platinum-200	100
Gold-193	1,000
Gold-194	100
Gold-195	10
Gold-196m	100
Gold-198	100
Gold-199	100
Gold-200m	100
Gold-200	1,000
Gold-201	1,000
Mercury-193m	100
Mercury-193	1,000
Mercury-194	1
Mercury-195m	100
Mercury-195	1,000
Mercury-197m	100
Mercury-197	1,000
Mercury-199m	1,000
Mercury-203	100
Thallium-194m	1,000

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Thallium-194	1,000
Thallium-195	1,000
Thallium-197	1,000
Thallium-198m	1,000
Thallium-198	1,000
Thallium-199	1,000
Thallium-200	1,000
Thallium-201	1,000
Thallium-202	100
Thallium-204	100
Lead-195m	1,000
Lead-198	1,000
Lead-199	1,000
Lead-200	100
Lead-201	1,000
Lead-202m	1,000
Lead-202	10
Lead-203	1,000
Lead-205	100
Lead-209	1,000
Lead-210	0.01
Lead-211	100
Lead-212	1
Lead-214	100
Bismuth-200	1,000
Bismuth-201	1,000
Bismuth-202	1,000
Bismuth-203	100
Bismuth-205	100
Bismuth-206	100
Bismuth-207	10
Bismuth-210m	0.1
Bismuth-210	1
Bismuth-212	10
Bismuth-213	10
Bismuth-214	100
Polonium-203	1,000
Polonium-205	1,000
Polonium-207	1,000
Polonium-210	0.1
Astatine-207	100
Astatine-211	10
Radon-220	1
Radon-222	1
Francium-222	100
Francium-223	100
Radium-223	0.1
Radium-224	0.1
Radium-225	0.1
Radium-226	0.1
Radium-227	1,000
Radium-228	0.1
Actinium-224	1
Actinium-225	0.01
Actinium-226	0.1
Actinium-227	0.001
Actinium-228	1
Thorium-226	10
Thorium-227	0.01
Thorium-228	0.001
Thorium-229	0.001
Thorium-230	0.001
Thorium-231	100
Thorium-232	100
Thorium-234	10
Thorium-natural	100
Protactinium-227	10
Protactinium-228	1
Protactinium-230	0.1
Protactinium-231	0.001
Protactinium-232	1
Protactinium-233	100
Protactinium-234	100
Uranium-230	0.01
Uranium-231	100
Uranium-232	0.001

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Uranium-233	0.001
Uranium-234	0.001
Uranium-235	0.001
Uranium-236	0.001
Uranium-237	100
Uranium-238	100
Uranium-239	1,000
Uranium-240	100
Uranium-natural	100
Neptunium-232	100
Neptunium-233	1,000
Neptunium-234	100
Neptunium-235	100
Neptunium-236 (1.15x10⁵y)	0.001
Neptunium-236 (22.5h)	1
Neptunium-237	1.001
Neptunium-238	10
Neptunium-239	100
Neptunium-240	1,000
Plutonium-234	10
Plutonium-235	1,000
Plutonium-236	0.001
Plutonium-237	100
Plutonium-238	0.001
Plutonium-239	0.001
Plutonium-240	0.001
Plutonium-241	0.01
Plutonium-242	0.001
Plutonium-243	1,000
Plutonium-244	0.001
Plutonium-245	100
Americium-237	1,000
Americium-238	100
Americium-239	1,000
Americium-240	100
Americium-241	0.001
Americium-242m	0.001
Americium-242	10
Americium-243	0.001

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Americium-244m	100
Americium-244	10
Americium-245	1,000
Americium-246m	1,000
Americium-246	1,000
Curium-238	100
Curium-240	0.1
Curium-241	1
Curium-242	0.01
Curium-243	0.001
Curium-244	0.001
Curium-245	0.001
Curium-246	0.001
Curium-247	0.001
Curium-248	0.001
Curium-249	1,000
Berkelium-245	100
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Californium-244	100
Californium-246	1
Californium-248	0.01
Californium-249	0.001
Californium-250	0.001
Californium-251	0.001
Californium-252	0.001
Californium-253	0.1
Californium-254	0.001
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Einsteinium-250	100
Einsteinium-251	100
Einsteinium-253	0.1
Einsteinium-254m	1
Einsteinium-254	0.01
Fermium-252	1

APPENDIX C TO §§ 20.1001–20.2401 QUANTITIES [1] OF LICENSED MATERIAL REQUIRING LABELING—Continued

Radionuclide	Quantity (μCi)
Fermium-253	1
Fermium-254	10
Fermium-255	1
Fermium-257	0.01
Mendelevium-257	10
Mendelevium-258	0.01
Any radionuclide other than alpha emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition	0.01

[1] The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in table 1, columns 1 and 2, of appendix B to §§ 20.1001–20.2401 of this part, rounding to the nearest factor of 10, and arbitrarily constraining the values listed between 0.001 and 1,000 wμCi. Values of 100 wμCi have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years (except rhenium, 1000 wμCi) to take into account their low specific activity.

Note: For purposes of §§ 20.1902(e), 20.1905(a), and 20.2201(a) where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" (i.e., "unity").

Appendix C to §§ 20.1001–20.2401 [Corrected]

7. On page 23468, in footnote 1 of appendix C to § 20.1001–20.2401, in the third column, "wμCi." which appears twice in line 6 and once in line 9, should read "μCi."

IDNS Form 4
January 1, 1994
PART 340

Illinois Department of Nuclear Safety

CUMULATIVE OCCUPATIONAL DOSE HISTORY

This State agency is requesting disclosure of information that is necessary to accomplish the statutory purpose described under Ill. Rev. Stat. 1991, ch. 111 1/2, par. 210-1 et seq. [420 ILCS 40]. Disclosure of this information is required. Failure to provide all information may result in enforcement action as provided by law. This form has been approved by the Forms Management Center.

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX MALE ☐ FEMALE ☐	5. DATE OF BIRTH

6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE

19. SIGNATURE OF MONITORED INDIVIDUAL	20. DATE SIGNED	21. CERTIFYING ORGANIZATION	22. SIGNATURE OF DESIGNEE	23. DATE SIGNED

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF IDNS FORM 4

(Enter dose equivalents in centisieverts or rem.)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr." "Sr." "III." etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee, registrant, or facility not licensed by the Department that provided monitoring.

8. Enter the Department license or registration number or numbers.

9. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee or registrant intends to assign the record dose on the basis of TLD results that are not yet available.

10. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE).

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ.

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the monitored individual. The signature of the monitored individual on this form indicates that the information contained on the form is complete and correct to the best of his or her knowledge.

20. Enter the date this form was signed by the monitored individual.

21. [OPTIONAL] Enter the name of the licensee, registrant or facility not licensed by the Department, providing monitoring for exposure to radiation (such as a DOE facility) or the employer if the individual is not employed by the licensee or registrant and the employer chooses to maintain exposure records for its employees.

22. [OPTIONAL] Signature of the person designated to represent the licensee, registrant or employer entered in item 21. The licensee, registrant or employer who chooses to countersign the form should have on file documentation of all the information on the IDNS Form 4 being signed.

23. [OPTIONAL] Enter the date this form was signed by the designated representative.

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF IDNS FORM 5

(Enter dose equivalents in centisieverts or rem.)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee or registrant.

8. Enter the Department license or registration number or numbers.

9A. Place an "X" in Record or Estimate. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee or registrant intends to assign the record dose on the basis of TLD results that are not yet available.

9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-###x," for instance, Ce-137 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to 10 CFR 20 (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."

10D. Enter the intake of each radionuclide.

NOTE: Enter intakes in kilobecquerels or microcuries. Clearly indicate the units used. (1 μCi = 37 kBq)

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. COMMENTS.

In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Department in reference to the exposure report.

20. Signature of the person designated to represent the licensee or registrant.

21. Enter the date this form was prepared.

WORK PLAN FOR CHARACTERIZATION OF RADIOACTIVE CONTAMINATION 316 EAST ILLINOIS STREET, CHICAGO, ILLINOIS

Appendix C

PROJECT SCHEDULE TIMELINE

316 EAST ILLINOIS PROJECT
CHICAGO, ILLINOIS

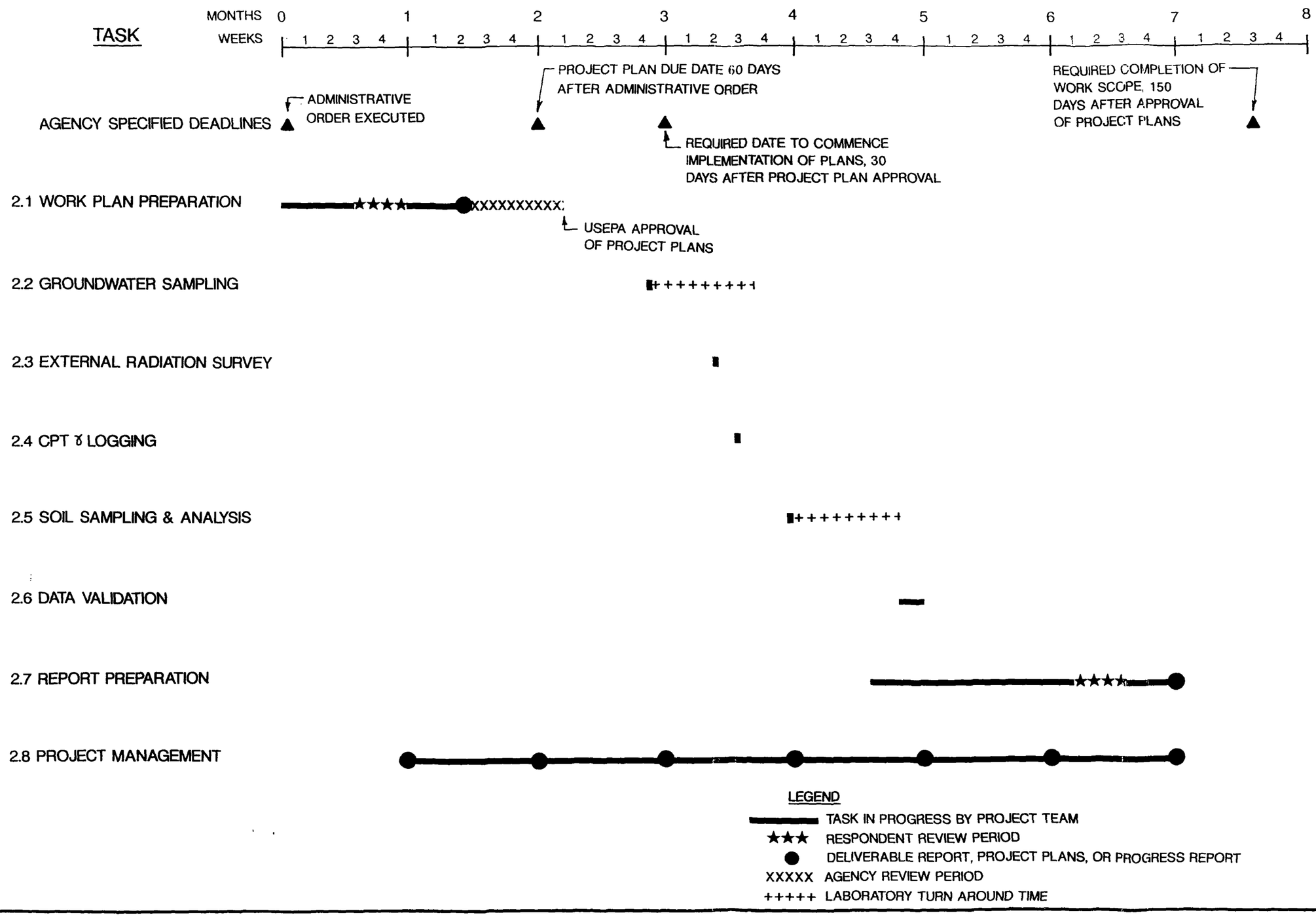
STS Consultants, Ltd.
111 Pfingsten Road, Northbrook, Illinois

Figure 1-1
Schedule for Work Plan Activities

Activity	Completion of Activity	Meeting
USEPA Approval of Work Plan	May 13, 1994	
Field Work Start-Up Meeting*		May 13, 1994
Field Investigation:		
Land Survey	May 14, 1994	
Overland Rad Survey	May 14, 1994	
Downhole Rad Survey/ Sampling	May 21, 1994	
Status Meeting		June 2, 1994
Laboratory Results	July 29, 1994	
Status Meeting		August 5, 1994
Completion of Investigation	September 23, 1994	
Draft Report Submitted	November 21, 1994	

*Assumes expedited USEPA review of previous activity.

CDock:AA3:seb



DRAWN BY KKB DATE 1-26-94
CHECKED BY DATE
APPROVED BY CSR DATE 1-26-94
CADFILE

SCHEDULE FOR
ADMINISTRATIVE ORDER INVESTIGATIONS
CHICAGO DOCK AND CANAL TRUST

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO. 27313-YH
STS PROJECT FILE
SCALE NTS
SHEET NO.